PROCEEDINGS

OF THE

Iowa Academy of Sciences

FOR 1897.

VOLUME V.

EDITED BY THE SECRETARY.

PUBLISHED BY THE STATE.

DES MOINES:
F. R. CONAWAY, STATE PRINTER.
1898.

nov. 12th '98

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LETTER OF TRANSMITTAL.

AGRICULTURAL COLLEGE,
AMES, Iowa, February 15, 1898.

To His Excellency, Leslie M. Shaw, Governor of Iowa:

SIR—In accordance with the provisions of chapter 86, laws of the Twenty-fifth General Assembly, I have the honor to transmit herewith the proceedings of the twelfth annual session of the Iowa Academy of Sciences.

With great respect, your obedient servant,

HERBERT OSBORN,
Secretary Iowa Academy of Sciences.

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1897.

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1898.

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Ex-Officio.—T. H. MACBRIDE, B. FINK, M. F. AREY, HERBERT OSBORN.
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PROCEEDINGS

OF THE

TWELFTH ANNUAL SESSION

OF THE

IOWA ACADEMY OF SCIENCES.

The twelfth annual session of the Iowa Academy of Sciences was held in the geological rooms at the capitol building in Des Moines, December 28 and 29, 1897. In business sessions the following matters of general interest were passed upon.

REPORT OF THE SECRETARY-TREASURER.

To the members of the Iowa Academy of Sciences:

I am pleased to report that during the past year the progress of the academy has been very satisfactory. Our proceedings forming a volume of 241 pages, 26 plates and the portrait of Dr. Wachsmuth were duly issued. They will, I believe, serve as a good indication of the activity of our members, and strengthen the position of our academy at home and abroad. A still larger membership would serve to extend the usefulness of the academy throughout the state.

FINANCIAL STATEMENT.

Accounts and vouchers submitted herewith show receipts of $154.17 and expenditures of $74.26 leaving a balance of $79.91.

SUMMARY OF RECEIPTS AND EXPENDITURES.

RECEIPTS.

Balance from last year	$	71.97
Members' annual dues		66.00
Membership fees		12.00
Proceedings sold		4.20
Total	$	154.1

EXPENDITURES.

Contribution to Pasteur monument fund	$	5.00
Stamps and stamped envelopes		5.36
Express and freight on proceedings		21.76
Reprints of Academy papers		37.00
Miscellaneous expenses		5.14
Total	$	74.26
Balance		79.91
Total	$	154.17

The committee appointed to examine the treasurer's accounts reported as follows:

The books and vouchers of the treasurer of the Academy of Sciences have been examined and found correct.

(Signed) M. F. AREY,
S. CALVIN,
A. C. PAGE,
Committee.

The librarian submitted a printed report as follows:

REPORT OF LIBRARIAN.

DES MOINES, December 27, 1897.

GENTLEMEN—In exchange for its proceedings, the academy is now receiving more than fifty periodical publications. In addition, a considerable number of individual books and authors' reprints come to it. The publications of the national and several state geological surveys are also received. These have been duly acknowledged and placed upon the shelves of the state library assigned to the academy.

Volume IV of the proceedings has been distributed to fellows, and to the American and foreign exchanges. A few exchanges have been added to the list.

Following will be found a memorandum of the periodicals now coming. In a few instances it has been possible, by sending both the proceedings of the academy and the reports of the geological survey, to obtain the back numbers of these publications. In several cases the numbers for the last few years are available:

PERIODICALS COMING TO THE ACADEMY.

Aateekeniger over Nederland; Versteeningen Leedsch, Geol. Mus.
Academia Mexicana, Annuar.
American Acad. Arts and Sci Proc.
American Journal of Pharmacy.
American Mus. Nat. Hist., Ann. and Bul.
Biological Soc. Washington, Proc.
Boston Soc. Nat. Hist., Proc.
Buffalo Soc. Nat. Hist., Bul.
California Acad. Sci., Occ. Pap., Proc.

Canadian Review of Science.
Central Ex. Farm. Bul.
Chicago Acad. Sci., Bul., Ann. Rep.
Cincinnati Soc. Nat. Hist., Jour.
Colorado College Studies.
Colorado Scientific Society, Proc.
Connecticut Acad. Sci., Trans.
Cornell Agri. Ex. Sta., Bul.
Davenport Acad. Sci., Proc.
Field Columbian Museum, Publications.
K. K. Zool., Bot., Gesell, zu Wien. Verh.
Illinois State Lab. Nat. Hist., Bul.
Iowa Agricultural, Bul.
Marine Biol. Lab. Rep.
Mededeelingen Omtrentde Geol. van Nederland.
Meriden Sci. Association, Trans
Minnesota Acad. Sci., Bul.
Mississippi Ex. Sta , Bul.
Museum Comp. Zoology, Bul.
Museum Nac. de Buenos Aires, Annales.
Museum Nac. do Rio de Janeiro, Archivos.
Museum Paulista, Rev.
Naturfor, Gesell in Berne, Mit.
Naturfor, Gesell. in Zurich, Vierteljahr.
Nebraska Exper. Sta., Bul.
New Brunswick Nat. Hist Soc., Bul.
New York Acad Sci. Proc , Trans
New York State Mus., Bul.
Observ. Meteor. Cent. de Mexico, Bul. Men.
Ohio Acad. Sci. Rept.
Ottawa Naturalist.
Perdue Ex Sta., Bul.
Philadelphia Acad. Nat. Sci , Proc
Portland Soc Nat Hist., Proc.
Psyche.
Rochester Acad Sci , Proc.
Royal Soc. Edinburgh, Trans., Proc.
Societe Entomologique de France, Bul
Societa Scientifica du Chili, Actes.
St. Laurent College, Bul.
St. Louis Acad Sci., Trans.
Texas Acad. Sci., Trans
Tuft's College Studies.
University Studies.
Wisconsin Acad. Sci. Arts and Lit , Trans.

At the suggestion of the chairman of the library committee of the academy, I have also prepared and submit with this a list of the periodicals of which the state library possesses full, or nearly full, sets. In the list, the letters "fs" indicate that the set is complete. No attempt has been made to list the sets of which a few volumes only are on the shelves, except in

the case of those now being received. Neither is any mention made of strictly medical or trade publications, or of the large number of valuable works, such as the International Scientific Series, the Humboldt Library of Science, etc. The titles set in italics are those which were purchased upon the express recommendations of the academy. They show how ready and generous has been the response of the state librarian and the board of trustees of the library to the requests of the academy.

SETS OF SCIENTIFIC PERIODICALS IN THE STATE LIBRARY.

American Association for the Advancement of Science, Proc., I–XLII.
Amercian Geologist, fs.
American Geological Society, Bul., I–VI.
American Institute of Mining Engineers, Trans., fs.
American Journal of Science, fs.
American Naturalist, fs.
American Philosophical Society, Proc., fs.; Trans., I–III, VI, n. s., fs.
American Society of Civil Engineers, Proc., fs.; Trans., fs.
Annals and Magazine of Natural History, fs.
Annals of Botany, Vols. I–VII.
Beiblatter zu den Annalen der Physik und Chemie, fs.
British Association for the Advancement of Science, Repts., fs.
Chemical Society (London). Journal, fs.
Compt Rendus de l'Academie, 1895—
Histoire de l'Academie, 1699–1764;
Memoire Adoptez de l'Academie, tm. I–XI;
Machine de l'Academie, tm. I–VI.
Electrical World, fs.
Electrotechnische Zeitschrift, fs.
Engineering Magazine, fs.
Fontschrette der Elektro teknik, fs.
Franklin Institute, Journal, fs.
Johns Hopkins University Circulars, 1896—
Liebig's Annalen der Chemie, fs.
Linnean Society, Trans., fs.
Nature, fs.
Neues Jahrbuch fur Geol u. s. f., 1895—.
Philadelphia Academy of Science, Proc., I–XLVI.
Popular Science Monthly, fs.
Reale Instotuto Lombardo di Scienze et Littere, Rend., I–IV n. s., I–XXV.
Science, fs.
Scientific American (and supp's), fs.
Van Nostrands Eclectic Engineering Magazine, fs.
Wiedmans Annalen der Physik, fs.
Zeitschrift der Deutschen Geologischen Gesellschaft, nearly complete.
Zeitschrift fur Instrumentkunde, fs.
Zeitschrift fur Physicalische Chemie, fs.

It will be noted that in several instances the state library owns the back volumes of a given set, while the academy is receiving the current numbers; for example, the Proc. Phila. Acad. Nat. Sci., Proc. Amer. As. Adv.

Sci., etc. I would recommend that in all such cases the current numbers be turned over to the state librarian at the end of each year. By this means duplication will be avoided, the library will be relieved from the expense of purchasing the books, and the academy will be saved from the expenses incident to binding and preserving them. I would further recommend, that in cases where the books received by the academy duplicate those received by the state library, the librarian of the academy be allowed to dispose of them upon the best terms available. I would further recommend, that, at the end of each year, all unbound books and pamphlets belonging to the academy be transferred to the state librarian, provided that the latter agrees to have them properly bound and preserved, and that they continue to be available for the uses of the members of the academy.

I would further recommend, that the academy petition the board of library trustees to allow the members and fellows to withdraw, under such regulations as they may devise, books from the scientific department of the library.

A memorandum of sales of proceedings and expenses incurred by the librarian will be found in the treasurer's report.

Respectfully,

H. FOSTER BAIN.

In addition to the regular papers read in full or by title and published herewith, the academy was shown a very full series of photographs of geological formations by Prof. J. L. Tilton.

Prof. F. W. Sardeson, of Minnesota State university, and Prof. J. E. Todd, state geologist of South Dakota, were in attendance and participated in the discussions.

Professor Sardeson was by motion invited to address the academy, and responded by cordially expressing his pleasure at being able to attend the session, and appreciation of the courtesies extended.

Touching upon the discussion that had followed the reading of papers on Loess formation he made the following:

REMARKS ON THE LOESS.

F. W. SARDESON, STATE UNIVERSITY, MINNESOTA.

(Abstract.)

The speaker commented on the common discrepancies in the use of the name "loess," which are due to the different theories held by scientists as to the origin of the geologic formations called loess. He denied having any immediate intention of trying to solve the question of origin of the deposits called loess in Iowa and neighboring states, but commended the problem to the Iowa geological survey as the strongest agent for

the needed solution. Regarding the name "loess," however, the appropriateness of limiting the name strictly to deposits of æolian origin was urged. Since, in Iowa, the loess has been derived largely or chiefly from the glacial drift, a more exact terminology, distinguishing the "modified drift" from loess and other deposits was believed to be necessary. Thus the "till" when washed and assorted by water becomes "modified drift." The resulting gravel, the sands and the clays, are distinguishable from the wind-driven or æolian deposits, although the latter are largely derived from the "modified drift." Clays of the modified drift can be distinguished from æolian deposit, the true loess, and both of these from washed or "modified" loess. Oxidized loess, loess loam, would seem to be easily distinguisable from the typical loess. Further, the relationship between the till, modified drift materials, and the loess in the region of the type loess deposits of the world, *i. e*, in the Rhine valley, were reviewed, and the similar relationships which have been proved to exist in Iowa were recognized. Also the significance of the loess loams which are usually associated with each loess formation was considered—and finally the scientific and commercial value of these clays suggested the value of further detailed knowledge as to their occurrence.

THE PRESIDENT'S ADDRESS.

BY THOMAS H. MACBRIDE.

Gentlemen of the Academy:

When, a short time ago, I was advised by our indefatigable secretary that by virtue of having been chosen vice-president of this body, the duty of making the presidential address fell to my share, I was somewhat disconcerted. I was at first inclined to push my honors from me and to say that inasmuch as no time remained for the preparation of a suitable discourse, the presiding officer would simply waive his prerogative in that particular and pass to the next order of business.

On consulting precedent, however, I discovered, what I must have forgotten, that the annual address is often happily employed in the simple enumeration of the scientific achievements of the passing year, and in suggesting lines of future

activity. Inasmuch as such a plan affords the speaker opportunity to say pleasant things about his colleagues as well as to give free expression to some of his own peculiar notions which might not otherwise find audience at all, I have concluded to improve my opportunity and to implore your patience while for a little space I attempt to follow the example of my honored predecessors. I claim no novelty in what I have to say; I announce no discovery; I would simply (1) congratulate my colleagues on present prospects and (2) call attention to some matters which have for a long time profoundly impressed themselves upon my mind.

Since our last meeting activity in the scientific world at large has nowhere for a moment ceased. Physicists and biologists still vie with each other in the far-reaching range of their researches if not in the brilliancy of reported discovery. Since January 1, 1897, in the world of physics and chemistry so much has been accomplished in the way of applied science that even attempt to enumerate would be futile here. One writer declares the past year, in this particular, the most marked of the last quarter of the century. The applications of electricity to all sorts of analyses, especially qualitative, to the separation of minerals, reduction of valuable ores and similar problems will constitute the theme of by no means the least interesting chapter in the history of the century's scientific work. In pure chemistry the liquefaction of fluorine, in view of the immense technical difficulties which must be surmounted, is regarded as an especially noteworthy triumph of modern persistency, ingenuity, and skill. In the engineering field the most colossal enterprises are no sooner completed than others more gigantic, more stupendous still, are immediately proposed. Hutton's compressed-air locks to connect Chicago with the sea, to lift an Atlantic steamer over Niagara Falls, may be named as illustration.

In biologic science it is difficult to pick out the achievement of any defined period. All work is continuous. That of to-day includes that of yesterday, and forecasts what shall be told to-morrow. The final disposal of the oriental plague, its complete control, is the latest achievement in bacteriology. In general botany I esteem the discovery of motile nuclei, antherozoids in the sexual apparatus of Gingko and other similar forms the most interesting botanical revelation of recent days; binding as it does, still more closely the gymnosperms with the

vascular cryptogams and bringing into view more vividly than ever the marvellous continuity of the present and the past.

The geologists continue to interest the world in mountain-building on the one hand, and plain-building on the other; and drift sheets furnish this year, as last, the staple topic of discussion in all learned societies. And here again, the progress of science is marked, not so much by any special discovery, as by the continued accumulation of data, the gathering of new facts which bring into clearer and yet more vivid light the surprising alternations of climate and surface-level which have marked the recent history of the earth. Paleontology is for the present laid aside. Even Dubois' *Pithecanthropus* from Java has failed to excite much interest, chiefly because that ancient ancestor of earth's noblemen was less careful than he should have been in reference to the final disposition of his bones, and has left us, his far-off children, quite uncertain as to the particular terrene or horizon in which so long ago he laid him down to sleep with the patriarchs of the infant world. In geology, as in biology, the progress of science is continuous. The problems of earth-knowledge *Erd-kunde* are so vast that single years avail us not; decades and half-centuries are insufficient even to set such problems forth, to give adequate horizon, perspective; or even to accustom us, who are but sons of time, to vistas that open into past infinity. In fact the general progress of the science of the world seems to me to-day to lie in that quiet confidence with which the men of science approach their work, and the perfect equanimity with which on all sides truth receives a welcome hearing.

Turn we now to our own little corner of the planet, given over by fate for tillage to members of this academy, we may find gratifying evidence of progressive research, notwithstanding the fact that we are perhaps all employed during most of the year in other and routine work. In natural history the year has brought forth much of permanent value in the way of original investigation and report.

Aside from papers published in the proceedings of our last meeting, I may mention here Mr. Fink's papers on the Minnesota lichens, Mr. Pammel's on the grasses and forage plants of Iowa, Nebraska and Colorado; Mr. Shimek's account of the ferns of Nicaragua. Mr. Nutting has in press a monograph of the hydroids of the Atlantic coast and Mr. Osborn's work on "Insects Affecting Domestic Animals" has this year appeared in

a second edition; from the geological survey, we have two handsome volumes, replete with matters pertaining to the economic interest of our state, and almost every article bears the name of some member of this academy. These are simply a few of the publications which have come to my notice, but are sufficient to show the variety and high grade of scientific work undertaken in and for the state of Iowa by members of this body. It will be noticed that in many cases the work which I have described is in the line of practical utility.

This is true, of course, of most of the articles in the reports of the state geological survey and of many others. The fitness of this is unquestioned. Science is nothing if not beneficent. Her object is, and ever has been, the discovery and promulgation of natural truth, and the knowledge of truth is always practical. Not less valuable, therefore, even from a practical standpoint, are those researches which may seem to-day to have no direct bearing on man's physical well being. Theory in science, as elsewhere, often precedes practice, and pure science lays evermore the foundations for invention. Faraday did not invent the telephone, nor did Helmholz or Tyndall; these men simply studied energy, electricity, forms or modes of motion, and in due time sound and light were flashed about the world. Lieutenant Maury wrote the Geography of the Sea, a guide-book to the ocean; a thousand unknown mariners who individually toiled for the sake of pure knowledge brought him his data. Pure science studies the properties of light, practical science grinds lenses to formulæ, builds the telescope for astronomy, the microscope for the investigation of the world of life. Practical science investigates the wine industry of France; bacteriology results, a pure science, yet practical in everything that touches human weal. And so although I may seem to-night to commend especially those scientific labors which bear immediate fruit, I would not for a moment discourage other investigations which tend to no direct outcome of the visible, practical sort, but which find their justification on the yet higher plane where they offer satisfaction to the inquiries of genius and solace to the lonely spirit of enlightened man.

But, however this may all be, there are some other considerations to be here noted which seem rather to place us as members of the academy under obligations, especially at the present time, to the accomplishment of work of a practical every-day sort. In the first place we have, upon our own

motion, entered upon certain relations with the state, by which our proceedings are published annually at public cost. This puts us so far under obligation. We must render *quid pro quo.* Our publications should be such, at least in part, as should be of immediate use to our fellow men, to the citizens of this state. This may not seem an ideal situation for a learned academy, but it is, nevertheless, the situation.

In the second place, by the conditions under which we live, by our history, the circumstances of our social and political life, we are to-day as men professing scientific education, laid under special obligations. We are not members of an ancient community where generations have painfully toiled and by natural methods wrought out rules and customs under which the conduct of life is on the whole fortunate. Our destiny calls us rather to act at a most critical time, to be so far guides, to a people for whom everything is new, all conditions, especially physical conditions, unknown, untried; man's relation to the world and the relation of the world to the happiness of civilized man yet unascertained. Under these circumstances members of the Iowa Academy of Sciences are at least justifiable, if not surely to be commended, when for the present they turn aside from the more ideal pursuits of problems in pure science to the consideration of those which make for our temporal well-being as a people. If we see our fellow citizens following in any direction courses of conduct which our superior knowledge, no matter how acquired, leads us to believe disastrous in outcome, it is surely our duty as sons of knowledge to lift up our voices in warning protest, if we are not to be held accessories before the fact by those who in future shall judge this generation. In other words, the academy just at this junction of the state's history ought to be in some way a missionary organization for the spread of such principles of natural truth as affect the welfare of this particular part of the continent.

To illustrate. Aside from the mere matter of solar heat the most important factor to our existence is the supply of water. I am of the opinion that the important problem before the people of Iowa to-day is the maintenance over its broad prairies of an equable supply of moisture.

Could our science by any plan devised guarantee this we should deserve, if we did not receive, the grateful homage of all the future. The report by Mr. Norton is but a beginning

in this direction. Doubtless no one more than the author of that valuable paper recognizes the truthfulness of this statement. To know the truth in regard to deep wells, the extent of aquiferous beds, their sources of supply, their probable content, and the depth at which they must severally be sought is information of the most desirable and practical sort. But what of our supply of ground water? What of those superficial *couches* which give us the prairie spring, the long winding creek, our creeping rivers? In this direction lies a peril I believe for the state of Iowa to-day. There is in my opinion no question as to the facts in the problem. Everyone familiar with the case will, I believe, assent that the state as a whole, is much drier than it was forty or fifty years ago. It was at one time in all eastern Iowa, the common practice for each man to dig a well, for house or field, almost where he chose. A few feet below the surface, water was abundant. There is no such water supply now. Sloughs abounded from whose miry ooze the water seeped all summer long, and running water was found on every farm. There is no running water now; not because of dry seasons, but because of drainage. The insidious tiles exhaust the bed of the slough, and highway ditches on every square mile prevent all accumulation of surface water. Local rainfall is immediately carried away and has no time to soak down and fill subjacent porous layers. The soil has become dry, and for water supply the citizen must rely upon beds far down below, beneath one or more sheets of drift. This is one side of the question. Resultant from it, in part, appears another phenomenon, viz: the failure of our streams. The creeks unfed, dried many of them long ago, except as flushed, sewer-wise, by the rush of surface storm-water, and the rivers are manifestly diminishing year by year. The sands and clays from ploughed hillsides are choking their channels, sealing their slender fountains. The stripping of woods and forest from river and hillside, from the rocky banks has all tended in the same direction. The water-courses unshaded dry up in the summer sun. It is a fact often observed that trees by the highway keep the road muddy long after a rain. To the same effect operate groves and thickets along our streams. The Platte river goes dry in summer; and yet the Platte river is fed by eternal snows. Shall the Des Moines, the Cedar or the Iowa, dependent on rainfall fare better than the Platte when their channels are filled with sand and all protection of forest and

woodland have been stripped completely from their sides? As civilized men we have overthrown in all ways in flora, in fauna, in surface-conditions an equilibrium which nature after numberless oscillations had established and it remains for us as a people to reach quickly a similar pacific state under new conditions with different species, different forms.

But it is said time will solve these problems; implying, of course, that time will solve them happily and right. But time, like experience, keeps a dear school, and the proverb does not commend the mental acumen of those who wait for such instruction. Besides, as just said, time has already solved the problem, and in that solution there is absolutely naught of hope.

Iowa is not a tropical island, bathed by ocean dews and washed by diurnal rains, where superfluous vegetal wealth forbids labor and denies the possibility of want; on the other hand, our prairies, although of matchless fertility, lie just on the limit of the region of inadequate rainfall. We have had, hitherto, just enough humidity and no more. Minnesota and Wisconsin are nearer the lakes, and Missouri, nearer the gulf; west of us are the semi-arid regions, once ominously called the American desert, whose hot breath even now occasionally invades our western and central counties.

I am aware that the competent director of our Iowa weather service takes the view that the climate of Iowa is a constant; that the rainfall is probably also constant, taken one year with another over long periods of time. This we may admit as true with the probable exception that our data, if sufficiently extended backward, might show a gradual, though very slight, decrease for all the western Mississippi valley. The average rainfall of the past eight years has been for Iowa as follows:

	INCHES.
1890	31.12
1891	33.13
1892	35.74
1893	27.31
1894	21.95
1895	26.63
1896	37.45
1897 (11 months)	24.98

We pass through seasons dry and wet; as Mr. Sage expresses it we have our "ups and downs"; but is it not plain that it is not so much the volume of rainfall in this part of the world as the amount of it, that in our processes of agriculture and else-

where, we are enabled to use that must be considered. All that may be said in reference to constancy of our climate and the average uniformity of our rainfall may be granted, and yet I believe that the problem I have broached is a real one, a very real one, worthy the consideration of this body and demanding now the most serious attention at the hands of this whole people. The rainfall may be absolutely constant, or subject only to variations such as are continental, planetary if you please in origin, and yet the *amount of moisture available for use in any particular locality for any given time may depend on causes which may be traced wholly or in great part to human agencies.*

Such cases are, therefore, under our control. As I have already remarked, our methods of agriculture affect in profoundest fashion the recipient and retentive characters of the ground.

Permit me to carry my argument a little further. Our streams are threatened because we have cut off their sources of perennial supply. Omnipresent drainage and tillage has affected, is affecting, more and more their constancy.

The question of general humidity interests primarily the farmer, and the farmer is mainly responsible for present conditions and tendencies; but, the existence of our rivers affects those of the city perhaps even more than those of the field. Along the Iowa river for instance are Eldora, Iowa Falls, Marshalltown, Iowa City, and other towns of only less importance, all dependent upon the river for their water supply. The Iowa river rises in Hancock county. Until within a few years that county contained thousands of acres of marsh land, peat-bogs, lakes, among which Eagle lake was large enough to receive a name. What is the situation now? The marshes of Hancock county have been drained, the peat-beds support harvests of grain, and Eagle lake has given place to corn fields over which passes, autumn and springtime alike, the farmer's triumphant plow. The history of smaller tributaries to the river is precisely the same, all the way until it receives the Cedar and finally pours a diminished flood into the Mississippi. The same thing is true of the Skunk river, the Coon, the Des Moines; and yet cities not a few are dependent more or less entirely on these streams for water. This is aside from all interests the farmers have in the streams, interest practical or theoretical. It may be said that the cities have resources; they may sink artesian wells. But we have yet to prove that this is practic-

able. In fact it has been tried in some places and found impracticable. But, wells or not, wet seasons or dry seasons, rainfall or no rainfall, Iowa cannot afford to become at any time absolutely desiccated if in any way such catastrophe can be averted.

But, you say, how is this matter to be remedied? Can we turn back the index on the dial-plate of time? No; it is not to be expected that original conditions can ever be restored. It is not even desirable to bring them back at all. Public interest, public sanitation would doubtless demand that the bogs be drained. Besides, some system of ponds or artificial lakes may probably be some day established, whose overflow may avail somewhat to replace the lost surface reservoirs which our agriculture has destroyed. More than this, if when we consider the fate of our streams we take into account at once the woodland and the prairie, there has been since the settlement of Iowa gain as well as loss. We have lost on the prairie, and aside from recent destructive tendencies have gained in the wooded areas. The second-growth thicket is a much better retainer of moisture than were the primeval woods. These were in great measure open; they were fire-swept nearly every year, and the stratum of leaves, mosses, and humbler plants which in true forest conditions lie like a sponge over the whole surface, was entirely wanting.

Our new forest has been until recently, actually much more extensive, much more dense, much richer in leaf-mould and in every way fitter for the true work of a forest in the direction of determining the volume of local moisture. We have but to emphasize this advantage to equalize at least in some degree our manifest losses.

My argument then comes simply to this: I contend that the narrow measure of Iowa's woodland should as such be religiously preserved and in a thousand places extended. Every rocky bank, every steep hillside, every overhanging bluff, every sandhill, every clay-covered ridge, every rainwashed gully should be kept sacredly covered with trees; every gorge, sinkhole, should be shaded, every spring be protected, every streamlet and every stream and lake bordered and overshadowed. In short every foot of untillable land, and even a little more along creek and river-margins, should be clothed with woods, should be woodland, land not devoted to pasturage at all, but land devoted to woods for the conservation, as far as

may be, of the state's supply of surface moisture. By the voice of all authority, by the teaching of all experience, by every presumption of science such treatment of Iowa lands and such only is rational, wise, and hope-inspiring for the future.

But now the edict has gone forth that the woodland must be cleared; every forest must be hewn down We are told over and over again that Iowa has less waste land than any state in the Union, that she has hardly an acre that may not pass under the plow; and in our effort to make good our boast we are in danger of committing irretrievable damage upon what was indeed the most magnificent heritage of this whole Mississippi valley.

I have left out of view in this argument entirely the æsthetic side of this question, the necessity of streams and lakes and woodlands to the æsthetic side of human nature. The absolute need of the milder healing influences of natural beauty to our eager, anxious, overworked, care-burdened, gain-seeking people I have elsewhere found occasion to discuss. Nor have I touched at all the sentimental side of the problem. I have said nothing of Iowa as a home, as a land suitable in which to rear generation after generation of wise and happy children who shall grow up to love the place of their nativity and nurture; I argue now only for Iowa as a field, a great field enclosed by wires from which may still be forwarded train-load after train-load of corn and beef. The drainage of our prairies, the destruction of what little woods we have, these two things do, in my judgment threaten our wealth, threaten our hope of gain, and therefore ought to command the attention of our people to any reasonable discussion of the question and to commend any effort made to attain a definite knowledge of the truth.

But no sermon is complete without the application, and the question now rises what can the academy do in these premises? We can in the first place investigate. Scattered as we are over the broad domain of the state we can, as we prosecute other lines of inquiry, likewise observe the facts that bear upon the problem here presented. Perhaps the geological survey has already such a line of investigation well in mind. It would surely very properly supplement the discussion of artesian waters. More than this, as we accumulate information, we may take pains to disseminate the same. I am of the opinion that this academy might, with advantage to itself and the public, largely increase its membership and so widen its influence, and thus eventually

reach our myriad several communities, the ultimate sources of power.

Possibly the legislature might be induced to hasten such investigation as the situation would seem to demand. A year or two since we petitioned the legislature to take steps for the preservation of our lakes. I am not informed that the legislature ever considered the matter at all. But, however willing the legislature, the problem is too far-reaching, too intricate, for their action. What can the legislature do? Shall the state own the rivers and their banks? This might avail in Germany but is not once to be thought of under our democratic system. We must reach the communities. The people interested must own the wooded banks and rocky bluffs. Is it not to the interest of the city of Des Moines to own the sources of the Coon, the wooded banks and hills that protect its streams in summer? If New York city can own large watersheds of the Croton, and if the state of New York may sustain the Hudson valley by the magnificent Adirondack forest reserve; if the city of Boston may absolutely govern in all problems topographic, all the surrounding country, shall not the towns of Iowa find it to their interest also to protect by every means our meagre streams and scanty woodlands? Nay, may not all the people, locality after locality, be brought to see the true condition of affairs so clearly that the people will themselves, community with community, and neighborhood with neighborhood, combine to the accomplishing of a purpose so beneficent, so absolutely essential to the continued prosperity of our people?

Some of us have seen county after county almost across our state pay a heavy assessed tax for the construction of a railway deemed necessary to the country's development. A movement such as here contemplated would be cheap in comparison, as regards the first required outlay, and would return dividends not, as too often in the other case, in vexation, litigation and disappointment, but in ever-increasing profit, pleasure and benediction upon ourselves and our children. The cost would be wholly inconsiderable.

The people would act to-day if the situation were clearly understood. The question is whether we do the right thing now or wait until the expense shall be increased a hundred-fold. The preservation of springs and streams and forests will one day be undertaken as freely as the building of fences or bridges or barns. When that day comes, Iowa, once so fair in her vir-

ginal beauty of wild-flowered meadow and stream-washed grove, now so rich in all that comes from tillage and toil, will put on yet an added splendor, in that all her toil and tilth shall yield to wisdom's guidance; forest and meadow receive each in turn intelligent and appropriate recognition; beauty become an object of universal popular concern, and once again across the prairie state the clarified waters of a hundred streams will move in perennial freshness toward the great river and the sea.

THE MYXOMYCETES OF THE BLACK HILLS.

A PRELIMINARY NOTICE.

BY THOMAS H. MACBRIDE.

The species listed here were collected during the month of August, 1897, and represent the rather hasty gathering of a traveler who could not remain long enough at one place to do thorough work. The number of species ought to be extended to three times that here offered, and probably will be ere many seasons pass.

The Black Hills exhibit a very considerable range of summer climate, remarkable when we consider the very restricted limits within which such variation is displayed, a region about equal to a dozen Iowa counties. The foot-hills and southern plateaus are in summer excessively dry, drouth-stricken. The occasional showers that pass seem to make no special impression, the water falling at such times being almost immediately evaporated. On the other hand the central mountain peaks are covered with varied, flourishing, and abundant vegetation all summer long, seem to enjoy sufficient rainfall and are often enveloped by mists for days together, and are undisturbed by any hot, dry winds, from the southern and eastern plains such as constantly sweep and vex the lower levels. The temperature varies much also in different localities. At the lower levels, 1,000–2,000 feet, the heat by day is great, reaching 95–98° Fahrenheit; on the higher levels, probably owing in part to more abundant moisture, the temperature of the air by day seldom rises above 70°, and is often much below. It is so cold in the central hills that corn does not mature, and even oats and barley during the short season fail betimes for the same reason.

Such conditions would not seem specially favorable for organisms so sensitive and quickly responsive as are the slime-moulds. One region is during the warm season too dry; another where moisture is adequate would seem too cold. Nevertheless, I found Myxomycetes, in one stage or another, in every region visited. The only one characteristic which seemed to indicate unfavorable conditions was the scanty size of the fructifications, although there were exceptions even to this. However, on the whole, my specimens are poor and show nothing like the beauty and perfection of the same species as collected in the woods of eastern Iowa. Further annotation is more conveniently made in connection with the names of each particular species.

There is no attempt to revise the nomenclature which here in general follows the usage of American authors.

1. *Bartramia utricularis* Berkeley.

Only one gathering of old and weathered material near Hot Springs.

2. *Physarum cinereum* Pers.

Abundant on the buffalo grass (Bouteloua) in several places near Minnekahta. Found also on dried, weathered droppings of cattle and horses near Long Pine, Neb. This appears to be a ubiquitous species. Although not especially common, yet it appears in all sorts of places and is usually profuse in fructification.

3. *Physarum nefroideum* Rost.

Represented in this collection by a single gathering of small scattered stipitate sporangia. Collected at Custer.

4. *Cratereum aureum* (Schum.) Rost.

Once collected along Fall River near Hot Springs. The sporangia are immaturely dried up, but I believe correctly identified.

5. *Tilmadoche nutans* (Pers.) Rost.

A small colony of weathered sporangia from the neighborhood of Hot Springs.

6. *Spumaria alba* (Bull.) D. C.

The specimen is immature and small. It was collected as a milk-white plasmodium and passed into the fruiting phase in the collecting case.

7. *Didymium crustaceum* (Fr.) Rost.

One gathering, in fairly good condition. The species is quoted by Lister as from Poland and England and appears to

be here for the first time reported from this country. I have, however, good specimens from a single collection in Iowa made many years ago. The form is so peculiar that I do not believe it likely to be mistaken for anything else. It must simply be put down as rare.

8. *Diderma laciniatum* Phillips.

Fairly good specimens of what is believed to be this species were found near Custer on Buckhorn Mountain. Phillips gathered his material in the Sierra Nevada nearly thirty years ago. (Grev. V, p. 113, t. 87, fig. 2,) but so far as I know the species has not been reported since. In August last Mr. T. B. Ellis, of New Jersey, sent to our laboratory a specimen from Colorado which proves to be the same thing. The species is thus very interesting, not only on account of its own inherent beauty, but because of its rarity and range. As is well known the Black Hills constitute a sort of meeting ground for the flora of almost all parts of the country. *Betula occidentalis* Hook here meets *Betula papyracea* Marsh. *Pinus ponderosa* Dougl. stands side by side with *Picea canadensis* Mill, and *Populus tremuloides* Mx. overshadows *Amelanchier alnifolia* Nutt, and *Aconitum fisheri* Reich.; so that we are perhaps less surprised to find a delicate slime-mould on this side of the vast reaches of desert that lie between the Black Hills and the California Sierras.

9. *Comatricha typhina* Pers.

Typical, though small, specimens are in the collection from near Sylvan lake.

10. *Comatricha nigra* Pers.

Very beautiful, but unusually small, specimens of this species were collected on fallen logs of Cottonwood along the south fork of the Cheyenne river. As in other cases the colony was small.

11. *Stemonitis smithii* Macb.

Well defined specimens of this minute species occur on fallen pine logs near Hot Springs and Cascade. Lister applies this name to all our North American forms having ferruginous spores. But these forms certainly show a diversity too great to admit of their being thus associated. As here employed the specific name is restricted to small forms of scattered habit and very minute .002–.004 mm smooth spores. This is rare in the western Mississippi valley.

12. *Stemonitis microspora* Lister.

This name is applied provisionally to the form heretofore commonly distributed and recognized throughout the United States as *S. ferruginea* Ehr. The European type, if one may judge from the reports of authorities and from scant material in herbaria of this country, is plainly different from ours and the specific name suggested by Lister may be for the present adopted.

13. *Stemonitis fusca* Roth.

Not common. One colony especially noteworthy has the sporangia short, and the spores, while of the usual size and color yet marked by unusual episporic characters, unlike any observed in specimens from the eastern United States. *S. fusca* is here adopted to supplant both *S. fusca* and *S. maxima*, as the separation seems impracticable.

14. *Stemonitis webberi* Rex.

Typical and not rare. On Arnold's peak, near Hot Springs, but not in the central hills. The species seems to belong to the plains proper, and is probably an adaptation to a climate drier than that of Harney or Sylvan lake.

15. *Licea variabilis* Schrad.

Fine specimens were collected near Harney's peak.

16. *Tubulina cespitosa* Peck.

Common in the central hills. One fructification 4-6 inches wide stretched along the surface of a log for the distance of many feet.

17. *Eutoridium rozeanum* (Rost.) Wing.

One specimen only discovered. The plasmodium is at first milk-white, then pink; later the fruit becomes umber-brown as the spores mature.

18. *Cribraria aurantiaca* Schrad.

Specimens poor, but plainly referable to this species.

19. *Cribraria pyriformis* Schrad.

Material poor. Reference provisional, though probably correct.

20. *Cribraria minutissima* Schweinitz.

In the crevices of a weathered pine log near Custer were found beautiful specimens of this species. Schweinitz reported it common in Pennsylvania and Carolina in his day. Specimens from Iowa and from Missouri are in the university (Iowa) herbarium. Its minuteness withdraws it from general recognition so that it escapes collection, though probably widely distributed.

21. *Dictydium cancellatum* (Batsch).

This is rare in the hills, though so common everywhere else. The specimens taken are unusually small. The stipe is short and unmarked above, although exhibiting the characteristic twist. This is *D. cernuum* (Pers.) Noes, as usually written, but Batsch surely recognized and figured the species, Elenchus II, 137, Pl. xlii, Fig. 232, and there seems no reason why the specific name he used should not pass current.

22. *Perichæna corticalis* (Batsch) Rost.

Rare, but in typical condition, and on the usual habitat, bark of fallen stems of *Ulmus americana.*

23. *Trichia fallax* Pers.

Typical in form and capillitium. Very dark colored, both within and without.

24. *Trichia inconspicua* Rost.

Typical. Occurring as in Iowa on bark of fallen stems of *Populus tremuloides.*

25. *Hemiarcyria varneyi* Rex.

Typical. Much resembles *Hemiarcyria clavata* (Pers.) Rost,, but has more slender threads, smoother and with abundant free tips.

26. *Hemiarcyria clavata* (Pers.) Rost.

Rare. Probably sought too early. Doubtless as common in the fall in the central hills as in other parts of the western states.

27. *Arcyria incarnata* Pers.

Rare. Collected only once, in a very light, delicate form, near Hot Springs.

28. *Arcyria nutans* (Bull.) Grev.

Found in small colonies on fallen willow stems, near Custer. Typical.

29. *Arcyria pomiformis* Rost.

This is an exceedingly delicate form. The peridium is wholly evanescent, the stipe very short, the threads regularly marked by the transverse plates or ridges characteristic of the genus. The spores are entirely smooth, about .008 mm.

30. *Lachnobolus incarnatus* (A. & S.) Schroeter.

Typical specimens were collected on the bark of fallen *P. tremuloids*, near Harney's peak.

21. *Lycogaha epidendrum* (Buxb.) Fr.

Rare. Only a single specimen observed near Custer.

THE FLORA OF THE SIOUX QUARTZITE IN IOWA.

BY B. SHIMEK.

II.*

A further study of the flora of this restricted exposure during the third and fourth weeks of last June offered certain suggestions upon geographical distribution which are here briefly presented.

In addition to the area described in the first paper on this flora (l. c. p. 72) a second exposure was examined. This lies near the Big Sioux river, nearly two miles west of the first exposure, and extends quite to the state line. It resembles the first exposure, but its surface is more broken, and also much greater in area. Near the central part there is a deep depression, occupied in part by a large pond. This exposure is likewise chiefly horizontal, but around the central depression, and also on the sides nearest the Big Sioux river, vertical sections are prominent, those at the latter point being fifteen to twenty feet high. Near their base there is an accumulation of soil which gradually runs out into the narrow alluvial valley of the Big Sioux river.

At the base of the lower ledges in the first exposure similar richer soil is found bordering small pools, which are connected only during flood periods.

Upon this soil at both points, but chiefly at the former, was found a flora similar (in so far as it is developed) to the flora of the more easterly portions of the state, and to the floras of our river courses. The species, which are enumerated in Table I, are all common and well known eastward.

Within a few feet, upon the exposed or scantily covered rock, were abundant specimens of the plants, which in that region at least, are peculiar to the rock exposures. In addition

*The first paper on this flora appeared in the Proc. Ia. Acad. Sci., Vol. II, pp. 72-77.

to those already listed as characteristic of the rock exposures (*l. c* p. 73) there were added the following species:

Schedonnardus texanus Steud. Common.

Potentilla pennsylvanica var. *strigosa* Lehm. Not common.

Gilia linearis Gray. Common.

Euphorbia obtusata Pursh. Rather common.

The lichens enumerated on pp. 74–5 (l. c.) should also be transferred to this list, as all of the species were collected in much greater numbers upon the most exposed portions of the outcrops, and as comparatively few specimens are found upon the straggling bowlders over the surrounding prairie, they are rather characteristic of the rock exposures. Upon the more pronounced soil which runs in and out among the exposures of rock from the adjacent prairie, is a still different flora made up of species which are peculiar to dry prairies, or which from their ready adaptability to circumstances are often found upon them. The species which have not already been listed (*l. c.* pp. 74–5) are enumerated in Table II.

Surrounding the pond and pools, or growing in them, were representatives of still another flora consisting of aquatic and marsh species, most of which are common eastward. The additional species of this group are reported in Table III. The first and fourth groups represent an eastern flora, and the second and third groups a flora more nearly western in its relationship (*l. c.* p. 76).

We have here, then, four distinct floras meeting upon a very restricted area. The lines between them are sharply drawn (excepting perhaps that between the second and third groups), and the collector need but take two or three steps to pass from the aquatic and alluvial flora of the east to that of the dry plains of the west.

A general comparison of the plants and of the conditions existing in June and August* brought out the fact that the prevailing plants of the region which belong to the eastern flora flowered and matured earlier in the season while the influence of the spring rains was still abundantly felt, while those which are more characteristic of dry grounds reached their development (*i e.*, flowered and fruited) later in the season after the drier summer period had fairly set in.

All this, of course, emphasizes the well-known fact that most plants are more or less restricted in their choice of hab-

*The plants discussed in the first paper were collected in August.

itat, and that while their seed may be scattered broadcast, only that will grow and blossom and bring forth fruit which falls within those conditions which render its existence possible. It is not probable that widely separated regions owe the similarity of their floras wholly to the accidental dropping of a few seeds. The floras of the Sioux Quartzite and of a portion of Muscatine county are in many respects similar, and quite unlike the intervening flora, yet it is not improbable that the broad area lying between them was once covered by their own kind.

Where distinct floras, requiring conditions for the best development, are brought as close together as is the case in the region under consideration, it is evident that with any considerable change in amount of rainfall one of the floras would suffer. With a comparative abundance of rains the alluvial and aquatic floras would have the advantage and would crowd upon their drouth-loving neighbors; while with a scarcity of rain these conditions would be reversed. A number of very wet or very dry consecutive seasons might therefore materially change the character of the flora of such a region. If, however, a general average was preserved, the dry soil and rock species would be at a disadvantage in the end, for they would gradually prepare a soil for their greedier neighbors who would slowly creep out upon their territory and finally take complete possession of it.

The study of such regions as that which includes the Sioux Quartzite exposures in Iowa, if conducted systematically and for a long period, ought certainly to throw light on the question of the succession of floras in the northwest.

TABLE I.

Species from the alluvial and richer soil

The species marked * were collected only at the first or eastern exposure. With two exceptions they are herbs, which do not appear in the list of the preceding year, having probably disappeared by the month of August.

Allium canadense Kalm. *
Amorpha fruticosa L. *
Ampelopsis quinquefolia Mx.
Anemone pennsylvanica L. *
Anemone virginiana L
Aquilegia canadensis L.
Celastrus scandens L.
Celtis occidentalis L.
Ellisia nyctelea L. *
Parietaria pennsylvanica Muhl.
Phlox pilosa L.
Prunus virginiana L.
Ranunculus abortivus L.
Rhus glabra L.
Rhus toxicodendron L.
Ribes floridum L'Her.
Ribes gracile Mx.
Rubus strigosus Mx.

**Euonymus atropurpureus* Jacq.
Fragaria virginiana Mill.
Fraxinus viridis Mx. f. (var.)
Fraxinus americana L.
Galium aparine L.
Galium trifidum L. f.
Hydrophyllum virginicum L.
**Hypoxis erecta* L.
Laportea canadensis Gaud.
Lathyrus palustris L.
Menispermum canadense L.
Nasturtium sinuatum Nutt.
Negundo aceroides Moench.
**Oxalis corniculata* L. var. *stricta* Sav.
**Oxalis violacea* L.
Oxybaphus nyctagineus Sweet.
Rumex britannica L.
Scrophularia nodosa L. var. *marylandica* Gray.
Silene stellata Ait.
**Smilacina stellata.*
**Smilax herbacea* L.
Specularia perfoliata S. D. C.
Thalictrum purpurascens L.
Tilia americana L.
Ulmus americana L.
**Veronica peregrina* L.
Vicia americana Muhl.
Viola palmata L. var. *cucullata* Gray.
Vitis cordifolia Mx.
Zizia aurea Koch.
Equisetum lævigatum Braun.

TABLE II.

Additional species characreristic of, or rapidly adapting themselves to, dry prairies.

Agropyrum repens Beauv.
Ambrosia artemisiæfolia E.
Amorpha canescens Nutt.
Anemone patens L. vas. *nuttalliana* Gray (in flower).
Asclepias tuberosa D.
Astragalus caryocarpus Ker.
Ceratium nutans Raf.
Erigeron strigosum Muhl.
Festuca tenella Willd.
Hedeoma hispida Pursh.
Heuchera hispida Pursh.
Hordeum jubatum L.
Hordeum pusillum.
Kœlena cristata Pers
Lepidium intermedium Gray.
Lepidium virginicum L.
Linum sulcatum Rid.
Œnothera serrulata Nutt.
Panicum dichotomum L.
Panicum scoparium Lam.
Pentstemon laevigatus Sol.
Potentilla arguta Pursh.
Quercus macrocarpa Mx. var. *olivæformis* Gray.
Senecio aureus L.
Silene antirrhina L.
Sisymbrium canescens Nutt
Stipa spartea Trin.
Symphoricarpos occidentalis Hk.
Tradescantia virginica L.
Verbena stricta Vent.

TABLE III.

Aquatic or marsh species.

These are additional to the former list (*l. c.*, pp. 74–5).

Alopecurus geniculatus L. var. *aristulatus* Zorr.
Eleocharis acicularis R. Br.
Eleocharis ovata L. Br.
Eleocharis palustris R. Br.
Eleodea canadensis Mx.
Nymphœa reniformis Dc.
Polygonum hartwightii Gray.
Sagittaria variabilis Engelm.
Sparganium eurycarpum Engelm.
Spirodela polyrrhiza Schleid.

IS THE LOESS OF AQUEOUS ORIGIN?

BY B. SHIMEK.

Organic remains furnish the best criterion for the measure of conditions which prevailed during any given age of the earth's geological history, provided, of course, that their relation to the deposit can be clearly shown.

To such an extent is this true of the older rock formations, that the modern geologist has generally accepted without question the conclusions long ago reached by the paleontologist, and has turned his attention to the physical, rather than the biological, phenomena presented by the various horizons.

In every case the paleontologist reached these conclusions in the main by comparisons with modern forms of life. The more remote the age, the greater the gap between its fauna and the fauna of the present day. Ordinal, family, and at best generic characters and relationships alone furnish a clue to the then existing conditions. Yet these have been considered sufficient. How much easier then is the task, and how much more satisfactory the deductions, if in the investigation of a much more modern horizon, we find the similarity of faunas extending to the species, and if for purposes of study we may place by the side of its fossils representatives of the same species which exist abundantly to-day under conditions which may easily be studied.

This is the advantage presented by the fauna of the loess. This fauna is in the main molluscan. A few remains of the vertebrates have been found, but the characteristic, most abundant and most widely distributed species are molluscs, and to these we must turn for the chief paleontological explanation of loess conditions.

The majority of the geologists who have given attention to

the loess of the Mississippi valley have ascribed its deposition to water in lakes or sluggish streams *

Some have also contended that this occurred in a glacial climate, or at least in a climate much colder than that of to-day in the same region. †

That fresh water has been regarded as the agent of deposition is due in no small degree to the belief that a very considerable portion of the species and individuals found in the deposit consists of aquatic or semi-aquatic forms, although the fact has long been recognized that terrestrial species prevail. There is, however, absolutely nothing in the loess fauna to indicate that the loess land-surfaces were more moist, or to any extent more widely or more deeply covered with waters, than are the surfaces of Iowa and Nebraska to-day,—the evidence, if it suggests any difference, indicating rather less moisture than is found in eastern Iowa at the present time. This statement, which cannot be too strongly emphasized, is based upon the study of the modern molluscs of Iowa and Nebraska, and their fossil prototypes, extending over a period of nearly twenty years.

Every species of molluscs which has thus been reported from Iowa, Nebraska,‡ and Missouri is living to-day,§ and with three or four exceptions all are found living within the territory covered by the loess. The conditions which are offered for comparison are therefore exceedingly favorable.

The following account of the species of *Mollusca* which are are found in the loess is given with special reference to the habits of the modern forms. Table I at the close of the

*The following are among the chief references: G. C. Swallow, Geol. Sur., Missouri, Vols. I and II, p. 74; W. H. Pratt, Proc. Dav. Acad. Sci., Vol. I, p. 97; C. A. White, Geol. Sur., Iowa, Vol. I, pp. 113 and 115; Sir Chas. Lyell, Prin. of Geol., Vol. I, p. 461; W. J. McGee, Proc. Am. A. A. S., Vol. XXVII, p. 83; Archibald Geikie, Text-book of Geol., p. 884 (he adds, however, that the loess shades off into rain-wash and æolian formation); S. Aughey, Sketches of Phys. Geog. and Geol. of Neb., p. 273, *et seq*; R. D. Salisbury, Ark. Geol. Sur., Vol. II., pp. 225-230; McGee, Rep. U. S. Geol. Sur., Vol. XI, p. 574, etc. More recently Prof. Calvin shows in the Rep. Iowa Geol. Sur., Vol. VII, p. 89, that the loess materials are derived from the drift, but says that the nature of the agents ..... "is not so clear." He adds that the piling of loess around the margin of the drift is better explained by currents.

†Some of the references are as follows, J. E. Todd, Proc. Am. A. A. S., Vol. XXVII p. 6; W. J. McGee, Proc. A. A. A. S., Vol. XXVII, pp. 81-2; W. J. McGee and R. E. Call, On the loess and Associated Deposits of Des Moines, pp. 22-3; R. D. Salisbury, Rep. Ark. Geol. Sur., Vol. II, p. 229; W. J. McGee, U. S. Geol. Sur., Vol. XI, p. 574, etc.

‡No account is here taken of Professor Aughey's long list of southern forms from the Nebraska loess, its unreliable character having already been pointed out by the author in Bull, Lab. Nat. Hist. State Univ. of Iowa, Vol. II, p. 95.

§*Zonites Shimekii* Pilsbry, the only species thus far accredited to the loess alone, is undoubtedly the widely distributed terrestrial *Zonites nitidus*.

paper contains the names of the species which have been authentically reported from the loess, or which are in the author's private collection. The numbers opposite the names show the number of cleaned specimens in the collection which are available for immediate study. Only those from the loess of Iowa and Nebraska are there included, and they are divided into two groups,—those from the eastern loess (the territory including the counties of Des Moines, Muscatine, Scott, Dubuque, Bremer, Johnson, Iowa, Polk and Warren in Iowa), and those from the western loess (from the counties of Fremont, Pottawattamie and Woodbury in Iowa, and Otoe, Sarpy, Cass, Douglass, Lancaster, Saunders and Cumming in Nebraska). The numbers are given for the purpose of showing the relative number of specimens of the various species which have accumulated in the collection in nearly a score of years, and which form the basis for this paper. Of course this does not represent the entire number collected, for many have been sent out in exchange. Neither does the table show the exact ratio of the fossils in the loess, for of the common terrestrial forms many were observed but not collected, whereas of the rarer forms and of the *Limnææ* nearly all which were observed were taken, and few or none were sent out in exchange. The fossils were compared with many thousands of modern specimens.

1. *Aquatic or semi-aquatic Mollusca.*

The forms which may properly be included under this head are the species of *Limnæa Physa*, *Bulinus*, *Planorbis* and *Segmentina*, all of which are, however, pulmonates—and *Valvata*, *Pisidium* and *Unio*, which are branchiate, strictly aquatic species.*
Special stress has been placed upon these forms as proving the presence of large bodies of water during the deposition of the loess. The weight of their testimony is here considered in detail.

Limnæa.—It will be observed in Table I that there are at present in the author's collection 771 fresh water specimens, of which 750 belong to the pulmonate genus *Limnæa*. Of the latter number over 300 specimens were collected near Iowa City in a "pocket," the exposed cross-section of which does not exceed four square feet in area. The remaining specimens were also found in restricted areas (as though deposited at the edge of a pool or pond),—never being so generally diffused

*Swallow's *Amnicola lapidaria* from Missouri (see Table I) is *Pomatiopsis lapidaria* a terrestrial species.

through the fossiliferous loess as are some of the Succineas and other terrestrial forms. Considering them rare in the loess the author collected a number out of all proportion to the ratio which actually exists between them and the terrestrial forms.

The great majority of the specimens are *L humilis* Say. Mingled with this species, and not always distinguishable from it and from each other, are *L. desidiosa* Say, and *L caperata* Say. All these species are rather small compact *Limnææ*, such as chiefly characterize our pond air-breathing molluscan fauna of to-day. The first two species may be found creeping about, in and near springs, streamlets, and small ponds, in all the region covered by the loess, and *L. humilis* especially is quite as frequently found out of the water as in it. Both are abundantly developed in ponds and streams which are dry during the greater part of the summer. *L. caperata* is also a common species to-day, and like the two preceding species is often found in ponds which are dry during most of the year. Near Lincoln, Neb., this species is common in prairie-ponds which usually contain water for but a few weeks in the spring, and last summer the author found it abundant upon the Sioux Quartzite exposure in northwestern Iowa in a pool which contained scarcely a gallon of water. It is noticeable that these recent prairie specimens are of the small "depauperate" type which occurs in the loess. Neither the habits of these species nor their distribution in the loess indicate the presence of any large bodies of water. They could be much more abundant and yet could not form as conspicuous a part of the fauna of the loess as the same species do of the fauna of our comparatively dry weather prairies to-day.

The larger *L. reflexa* and *L palustris* mentioned in the table, while locally common in larger ponds and prairie swamps to-day, have not been found in the loess of Iowa and Nebraska. They, too, are air-breathers, and never occur in deep waters.

Physa.—Two specimens are in the collection, one from Iowa City, and one from Lincoln, Neb. Both are young and the species cannot be satisfactorily determined. Two species have been reported from Missouri by Swallow (*l c* p 215), but representatives of this genus are evidently very rare. The habits of all are essentially the same as those of the *Limnææ*.

Bulinus.—One species, *B. hypnorum*, has been reported from Missouri by Swallow (*l. c.*). It has not been found in the loess of Iowa and Nebraska. The species is found now in prairie

ponds in Iowa and Nebraska, and seeks the habitats which are agreeable to *Limnæa palustris*.

Planorbis.—Two species have been recorded from the loess. *P. trivolvis* has twice been reported (see Table I), but in each case with doubt. *P. parvus* (it may be *P. dilatatus*) is rare in the western loess, five specimens only being in the collection. In habits these species of *Planorbis* are all, like the species of *Limnæa* and *Physa*, inhabitants of shallow water borders.

Segmentina.—One species, *S armigera* has been reported from Missouri by Swallow. It is evidently extremely rare. The species is now locally common, especiclly in prairie ponds, and in habits is similar to *Planorbis*

All of the foregoing species are air-breathing, and all are found living abundantly in Iowa and Nebraska to-day. Their presence not only does not prove that there was an excess of moisture, but their scarcity actually suggest that there was less water than may now be found over the same areas.

Valvata. One species, *V. tricarinata*, has been reported from Missouri (see Table I). This and *Campeloma subsolidum* are the only branchiate aquatic Gasteropods reported from the loess.*

It is now locally common in ponds and sluggish streams, often being found in ponds which become dry in summer. Its total absence from the loess of Iowa and Nebraska, and its scarcity in Missouri, make the species of little value in determining prevailing conditions in loess times

Pisidium.—Two valves only, of a species which has not been satisfactorily identified†, were found at Iowa City, associated with *Limnæa* in the little pocket to which reference has already been made. The species of *Pisidium* are small bivalves (hence gill-bearing and aquatic), which are locally common in all our fresh waters. They also frequently occur in ponds and streamlets which become dry during the summer. For two reasons the author collected numerous specimens of a species much like our fossils (probably the same) near Lincoln, Neb , in a streamlet which during both years was dry all summer.

The presence therefore, of aquatic forms of the foregoing types does not indicate that large bodies of water, whether in lakes or rivers, existed,—indeed it does not show that, even in the particular localities where they were developed, water was found during all the year. No doubt there was water. There

*Pomatiopsis lapidaria and Helicina occulta, both gill-bearing, but terrestrial in habit are considered with the terrestrial forms.

†For *Cyclas* from Missouri see Table I.

were rain and snow,—there were pools, and springs, and streams,—and it would be strange indeed if some evidence of water action, water-presence was not found. But the character of these fresh water fossils, and their comparative scarcity, indicate either that there were very few bodies of water, or that the loess was deposited chiefly where there was no water. Of the fresh water forms there remain to be considered the species of *Unio* and *Campeloma*. These may be discussed together for both genera are chiefly fluviatile, and are usually associated in our streams, while the record of their occurrence in true loess is about equally established. From two localities, only, have specimens of loess *Unionidæ* been reported.* Professor Witter reports† three species of *Unio* and one species of *Margaritana* from the loess of Muscatine.‡ All are recorded as "rare and local."

Mr. H. Foster Bain, of the geological survey, furnished the three species of *Unio*, represented by twelve valves, which are reported in Table I, from Sioux City. The author does not know whether any doubt exists concerning the correctness of the reference of these forms to unmodified loess.§

But granting that no such doubt does exist the evidence furnished by them that the loess was deposited under fluviatile conditions, is by no means conclusive. They are extremely rare in proportion to other molluscs, and the occurrence of such scanty material may be accounted for otherwise. The author has a number of times found shells of Unios at a considerable altitude above high water mark. The bluffs along the Iowa river above Iowa City have furnished several examples. Whether they were carried to their lodging places by bird or beast could not be determined, but some of the shells bore marks as of the teeth of a mammal. That there were streams in loess times is evident from present river courses and river valleys. That Unios occurred in these waters is quite probable. That some of these should have been carried to altitudes greater than those at which they were developed is

*To these should be added a third locality. McGee, in U. S. Geol. Sur., Vol. XI, p. 460, reports "fragile bits of shells of *Unio* or *Anodonta*" from Stone City, Iowa.

†Rep. U. S. Geol. Sur., Vol. XI, p. 471.

‡For list of species see footnote (15) under Table I.

§Since this paper was written Mr. Bain has submitted additional numerous valves of *Unio* from near the mouth of the Broken Kettle, Plymouth county, Iowa. A list of the species is given in Table III. With the Unios were associated a few shells of *Succinea lineata* and one specimen of *Helicodiscus lineatus*, both being of the ordinary loess type. The Unios were clustered in small heaps or pockets. Mr. Bain pronounces the deposit in which these shells, as well as those previously collected at Sioux City were found, to be a terrace of modified loess.

possible. But it is extremely strange, if the loess was deposited either in rivers or in lakes, that these remains of mussel shells are not more abundant. It has been suggested that the waters were too cold for the best development of the *Unionidæ*, but species of *Anodonta* of this family are common in lakes and sluggish streams far to the north, and over most of the northwestern territory, and, if such conditions prevailed, at least fragments of these should be found if the delicate egg-shells of a small snail (see Table I) were permitted to come down to us entirely uninjured. If the waters had been too cold for the *Unionidæ*, the land would likewise have been too cold for the land snails.

Moreover, the evidence of these four shells, while worthy of attention, should scarcely be permitted to outweigh that of the thousands of terrestrial forms so widely distributed in the deposits.

2. *Terrestrial molluscs.*—Of fossil terrestrial molluscs there are 4,816 specimens in the collection. Some of the forms here classified as terrestrial have frequently been incorrectly reported as aquatic or semi-aquatic. This is especially true of *Helicina*,* *Pomatiopsis*†, and *Succinea*‡. *Helicina occulta* Say, though gill-bearing, is strictly terrestrial. At Iowa City, where it was discovered by the author many years ago, and in Hardin county, where it is not rare, it is always found on steep hillsides high above high-water mark.

Pomatiopsis lapidaria Say is likewise wholly terrestrial. Call (*l. c.*) repeatedly refers to it as a fresh-water form, and, when we consider that a conchologist of such wide experience makes this error, it is not surprising that others repeat it. At Iowa City, Belle Plaine, Eldora, and other points where this species is common at the present time, it is usually associated with *Patula striatella* and *Succinea obliqua*, both likewise terrestrial forms, and is in no sense aquatic.

Succinea.—Two types of this genus appear. That represented by *S. ovalis* has a very large body-whorl and a short spire. These forms are mostly found in swampy places creeping about on semi-aquatic plants, or on mud, but not living in water. Of this type three specimens are in the collection.

*J. E. Todd, Proc. Am. A. A. Sci., Vol. XXVII, p. 6; F. M. Witter, "Notes on the Loess;" W. J. McGee, Rep. U. S. Geol. Sur., Vol. XI, p. 461

†R. E. Call, Rep. Ark. Geol. Sur., Vol. II, pp. 166, 167, and 178.

‡Lyell, Prin. of Geol., Vol. I, p. 460; J. E. Todd, Proc. Am. A. A. S., Vol. XXVII, p 6, F. M. Witter, Notes on the Loess; R. E. Call, On the Loess and Associated Deposits of Des Moines, p. 16.

The other type with smaller body-whorl, more exserted spire, and more convex whorls, is represented by *S. avara*, *S. lineata*, and *S. obliqua* These are not only not semi-aquatic, but are often found in high, very dry situations. This is especially true of the small form of *S. avara*, and of *S. lineata*, both of which are very common in the loess. Of this type there were 1,714 fossil specimens in the collection, and even if the three specimens of *S. ovalis* be accepted as "semi-aquatic," their importance is far outweighed by these strictly terrestrial forms.

Remaining forms.—Of all the remaining forms in the list it may be said that they are wholly terrestrial in habit. While they require a certain amount of moisture, that which is retained under a stick or leaf is sufficient. Most of the species are abundant to-day in both Iowa and eastern Nebraska, and several prefer a decidedly dry region.*

Their presence, therefore, does not prove a moist climate, but rather suggests less moisture †

In all discussions of loess conditions it should be borne in mind that the forms of mollus s which are everywhere present, and which are truly characteristic of the oess, are all terrestrial and none require much moisture.

So far as evidences of a glacial climate are concerned, this much may be briefly said: The climate was of necessity such as to permit the development of abundant plant-food for the terrestrial molluscs, for they are almost without exception herbivorous The fresh water pulmonate fauna of the loess, instead of being of the large, comparatively thin-shelled type which prevails northward, is more nearly like that of our comparatively dry prairies to-day, as has been stated

Great stress has been placed upon the depauperate condition of the shells of the loess ‡

With the exception of the extremely variable *Patula strigosa cooperi* the author has found every species occurring in the loess exhibiting modern mature forms which do not exceed, and in many cases are smaller than the fossils The conditions which produce the depauperation exist to-day in the loess covered

*This is especially true of *Patula strigosa cooperi*, *Pupa altic ola* and *Succin a lineata*.

†It may be added, parenthetically, that the larger shells, such as *Mesodon multilineata*, *M. profunda* and *Patula alternata*, often have their apices broken in exactly the same manner which may often be observed in fresh shells from which birds (blue jays, etc.) have extracted the animals.

‡J. E. Todd, Proc. Am. A. A. S., Vol. XXVII, p. 6; McGee and Call, On the Loess and Associated Deposits of Des Moines, pp. 21-3, and plate; Chas. R. Keyes, Bull. Essex Ins., Vol. XX, p. 5; W. J. McGee, Rep. U. S Geol. Sur., Vol. XI, pp 300-1, 435 and 448. See also author's paper in Bull. Lab. Nat. Hist. State Univ. of Iowa, Vol. II, pp. 93-4.

region, and their presence is no proof of a glacial climate, but may suggest a drier climate.*

3. *Mammals*.—The evidence furnished by the mammals is unsatisfactory, since in some cases, at least, there is doubt that the remains came from unmodified loess. Several species have been reported† all of them herbivorous and rare.

The scarcity of material, however, does not necessarily show that these forms were very rare (thus suggesting limited land areas), for we have quite the same difficulty in finding the bones of more modern mammals. The bones of the bison, deer, bear, etc., are seldom found, yet the species were once common. The rabbit and squirrel leave but few traces of their existence, yet they are common even now.

The presence of the fossil mammals, so far as it has any value in the present discussion, indicates plenty of plant-food, a possibility of extensive land areas over which these forms roamed.

Certain other questions, bearing largely on physical geography, are suggested to the student of the fauna of the loess. The fact that that the loess caps the hills has long been known. If the material was deposited in water, there must have been a body of the latter sufficiently large to cover these hills, for it is recognized that the general topography of this region was determined before the loess was deposited.‡ If there was such a large body of water, where are the evidences of its shore lines? It has been suggested§ that the waters were contained within walls of ice, but that hypothesis calls for climatic conditions which would make impossible the development of the life of which we find evidences.

Where, too, were the land areas upon which the molluscs and mammals flourished? It might seem plausible at first

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*This was suggested by the author in Bull. Lab. Nat. Hist, State Univ. of Iowa, Vol. II, p. 94, but was not sufficiently emphasized.

†The following have come to the author's attention:

Bootherium cavifrons Leidy, G. Hambach, Bull. I, Geol. Sur. Missouri, p. 82.

Castor fiber Ow. G. C. Swallow, Geol. Sur. Mo., Vols. I and II, p. 215; Hambach, l. c., p. 82.

Cervus muscatinensis Lidy, F. M. Witter, Notes on the Loess; Rep. U. S. Geol. Sur., Vol. XI, p. 471.

Elephas primigenius Blume, Swallow, *l. c.* p. 215; W. H. Pratt, Proc. Dav. Acad. Sci., Vol. I, p. 98; Hambach, l. c. p. 82; W. J. McGee, Rep. U. S. Geol. Sur., Vol. XI, p. 471 (quoted from Pratt, l. c.).

Mastodon giganteus Cur., Swallow, l. c., p. 215: Hambach, l. c. p. 82.

‡To this Prof. S. Calvin again recently calls attention in Geol. Sur. Iowa, Vol. V p. 69.

§McGee and Call,—On the Loess and Associated Deposits of Des Moines, pp. 22-3; McGee,—Rep. U. S. Geol. Sur., Vol. XI, p. 574.

thought that the remains now fossil drifted in from very remote regions. Land shells are imbedded to-day in fine alluvium along our streams,* but these are seldom carried to a distance, but are rather covered *in situ* by the fine silt of the stream. The above assumed conditions, however, would call for the transportation of the materials from great distances, and the larger shells would be precipated long before the fine silt had reached its destination, or if floating, would be thrown ashore in bands. Any observer who collects shells in river drift and then traces the rarer species of more restricted distribution to their source, can ascertain that these shells are not carried far. Dredging in "sloughs," ponds, and sluggish streams also shows that land shells are seldom washed into them.

Moreover the molluscan loess-fauna of any region is on the whole like the modern fauna of the same region. For example, Binney reports a number of species from the "post-pleiocene" (evidently the loess) of the lower Mississippi valley, of which eleven† are southerly species, and all now live in the same region. Call reports‡ fifteen species from the loess of Arkansas, three of them included in the southerly list in Table II, and all belong to the modern molluscan fauna of that state. The same is true of the faunas of Iowa and Nebraska as has been stated.

This does not indicate transportation from a great distance. It is interesting and noticeable that for the most part the species of the loess are common over the same region now. There are some exceptions, for there have been changes no doubt, but these changes, as indicated by the distribution of the shells, are no greater than may now be observed in any limited region in the course of a few years. Species are sometimes disposed to appear, disappear, and reappear in a surprising manner in a given locality, and, if we may judge from the vertical distribution of the fossil shells, the same was true during the deposition of the loess.

The horizontal distribution of the fossils is likewise such that it suggests at once that they were deposited *in situ.*§

As there are surface areas to-day which have no molluscs, lying in close proximity to those on which molluscs are abun-

*For author's account of an example see Bull. Lab. Nat. Hist, State Univ of Iowa, Vol. II, pp. 169-174.

†See Table II.

‡Geol. Sur. Ark., Vol. II, pp. 49, 165, and 166.

§For a further discussion of this point by the author see Bull Lab. Nat. Hist. State Univ. of Iowa, Vol. III, pp. 95-96.

dant, so there are deposits of loess without fossils, adjacent to those which are fossiliferous. As the lands, high or low, lying adjacent to larger streams have greater numbers of molluscs to-day than the outlying prairies, so the loess bordering these streams is usually much more fossiliferous than that which covers more remote areas,—but the distribution of the fossils is not in bands, as if drifted, but is similar to that of the modern specimens at the surface. Summing up the evidence of the fossils we may assert that it points to conditions not unlike those which exist to-day, and that geologists, in seeking for the cause and manner of the deposition of the loess must give up the assumption of widely submerged areas over which fossiliferous loess now occurs, and of a cold climate.

* * * * * * * * *

That the loess is not everywhere uniform in composition is recognized.* Especially marked is the difference between the loess in the counties in Iowa designed as eastern, and those in Iowa and Nebraska referred to as western, the former eing finer and washing readily, while the latter is more silicious and persists in vertical sections for a much longer time. These differences may possibly suggest a difference in mode of deposition, but so far as evidence is furnished by the molluscs, the climatic and surface conditions in both regions were essentially the same,—that is, they did not differ more than at present. A comparison of the species and number of specimens of each from the eastern and western loess, as given in Table I, shows that but few are not common to both, and these are mostly the rarer species. There are now equivalent differences between the faunas of the two regions, but the great majority of fossils as well as of recent forms is the same in both. The differences which exist between the two deposits are probably due to the different sources of material rather than to different agencies of deposition.

It seems evident that the loess materials originated largely or wholly in drift,* and as the comparatively recent investigations by members of the Iowa geological survey have demonstrated the presence of several drift sheets in this state, and as Nebraska has at least two such sheets, an interesting problem is suggested to geologists, namely: the determination of the relation which the various deposits of loess bear to those drift

*W. J. McGee.—Rep. U. S. Geol. Sur., Vol. XI, pp. 292 and 295, etc.

*R. D. Salisbury.—Ark. Geol. Sur., Vol. II, pp. 225-6; S. Calvin,—Iowa Geol. Sur., Vol VII, p. 89.

sheets which during the deposition of the loess were found at the surface of adjacent regions. This would involve a careful comparison of the finer materials in the drift with the loess, and the consideration of the probable or possible direction and means of transportation to the present location of the loess.

TABLE I.

LIST OF LOESS FOSSILS (*Mollusca*).

TERRESTRIAL FORMS	Eastern Loess.	Western Loess	Total.
Zonites radiatulus Alder..........................	2	9	11
Zonites arboreus (Say) Binn..........................		10	10
Zonites minusculus (Binn.) F. & C	3	3	6
Zonites shimekii Pils. (*nitidus*)......................	98	74	172
Zonites fulvus (Drap.) Binn........................	140	28	168
Zonites binneyanus (Morse) Binn reported (1).......			
Zonites indentatus (Say) Binn reported (2)...........			
Helicodiscus lineatus (Say) Morse....................	13	10	23
Patula strigosa cooperi W. G. B..........	85		85
Patula striatella (Anth) Morse.....................	288	206	494
Patula striatella eggs (3)...........................	6	14	20
Patula alternata (Say) Binn........................	61	54	115
Patula perspectiva (Say) Binn. Reported (1)........			
Macrocyclis concava (Say) Morse. Reported (2).....			
Stenotrema leaii (Ward) Binn. (*monodon*)............		24	24
Stenotrema hirsutum (Say) Fry......................		3	3
Mesodon multilineata (Say) Fry.....................	103	42	145
Mesodon albolabris (Say) Morse.....................		2	2
Mesodon profunda (Say) Binn......................	61	3	64
Mesodon thyroides (Say) Fry. Reported (2)..........			
Mesodon clausa (Say) Fry..........................	1		1
Mesodon divesta (Gld.) Fry. Reported (1)...........			
Vallonia pulchella (Muell.) Binn....................	66	190	256
Strobila labyrinthica (Say) Morse....................		2	2
Fernesacia subcylindrica (L.) Binn..................	12	16	28
Pupa holzingeri Sterki............................		3	3
Pupa armifera Say...............................	14	11	25
Pupa muscorum L.................................	72	183	255
Pupa contracta Say...............................		1	1
Pupa alticola Inger. (*simplex*)......................	247	50	297
Pupa fallax Say..................................		12	12
Pupa corticaria Say. Reported (4)................			
Other *Pupidæ* (5).................................	378	160	538
Succinea ovalis Gld................................		3	3
Other *Succineæ* (6)...............................	1.200	514	1,714
Carychium exiguum (Say) Gld......................	9		9
Helicina occulta Say.............................	180	150	330
Pomatiopsis lapidaria Say (7)......................			
Total terrestrial forms......................	3,039	1,777	4,816

AQUATIC OR SUB-AQUATIC FORMS.

Limnœa reflexa Say. Reported (2).............			
Limnœa palustris Mull. Reported (2).........			
Other *Limnœa* (8)................................	567	183	750
Physa gyrina Say (9)............................	1	1	2
Physa heterostropha Say (9)......................			
Bulinus hypnorum (L) Binn. Reported (10).........			
Planorbis parvus Say............................		5	5
Planorbis trivolvis Say. Reported (11)..............			
Segmentina armigera (Say) H. & A. Ad. Reported (12)			
Valvato tricarinata Say. Reported (2)..............			
Campeloma subsolidum Anth Reported (13)........			
Pisidium ——— —sp. (14)......................	2		2
Unio undulatus Barnes............................		6	6
Unio rubiginosus Lea.............................		5	5
Unio pustulosus Lea (15)..........................		1	1
Total aquatic forms........................	570	201	771

TABLE II.

List of fossil molluscs from the "Post-pleiocene deposits" [16].

Zonites fuliginosus (Griff.) Binn

Zonites intertextus Binn.

Zonites inornatus (Say) Biun.

Zonites gularis (Say) Binn.

Patula solitaria (Say) Binn. [17].

Stenotrema stenotrema (Fér.) Try.

Triodopsis palliata (Say) Binn.

Triodopsis obstricta (Say) Binn.

Triodopsis inflecta (Say) Binn.

Mesodon elevata (Say) Binn.

Mesodon exoleta (Binn.) Try.

Helicina orbiculata Say [18].

TABLE III.

List of Unios from modified Loess submitted by Mr. Bain.

These are all from near the mouth of the Broken Kettle, Plymouth county, Iowa.

Unio anoxontrides Lea.

Unio donaciformis Lea.

Unio elegans Lea.

Unio pustulosus Lea.

Unio rubiginosus Lea.

Unio undulatus Barnes.

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1. J. E. Todd, Proc. Am. A. A. S., Vol. XXVII, p. 6, from southwestern Iowa.

2. G. C. Swallow, Geol. Sur. of Mo., Vols. I and II, p. 215, from Missouri.

3. The eggs vary slightly in size. The smaller agree exactly with eggs of modern *P. striatella*. The larger may belong to another species.

4. R. E. Call, On the Loess and Assorted Deposits of Des Moines, pp. 14 and 17; from Des Moines Iowa. F. M. Witter, Rep. U. S. Geol. Sur. Vol. XI, p. 47.

5. These lots include *Pupa pentodon, Vertigo ovata*, etc., the greater part consisting

of the first species. All are represented in our Iowa molluscan fauna, and all are terrestrial, hence the general result is the same. They are not all reported in the collection, hence are not separately listed. A critical review of these and other forms will appear in a monograph of the loess *Mollusca*, which the author is preparing.

6. These include *S. obliqua*, *S. lineata* and *S. avara*. All belong to a division of the genus *Succinea* the species of which are terrestrial in habit, and occur living in abundance in Iowa and Nebraska to-day.

The remarks on *Pupidæ* in the preceding foot-note apply equally well to these *Succineæ*.

7. This is Swallow's (*l. c*) *Amnicola lapidaria* from Missouri. Todd (*l. c.*, p. 7) also reports it doubtfully from southern Iowa.

8. These include *L. caperata*, *L. humilis* and probably *L. desidiosa*. As many, especially young specimens, cannot readily be referred to their respective species, all are here grouped together. A more complete discussion of these forms will appear later. (See foot-note 5.)

9. *Physa gyrina* and *P heterostropha* have both been reported from Missouri by Swallow (*l. c.*) Our specimens are very young, but probably belong to *P. gyrina*.

10. Reported as *Physa elongata* by Swallow (*l. c.*) from Missouri.

11. Doubtfully reported by Todd (*l. c.*, p. 7) from southern Iowa, and by Witter (in notes on the Loess) from East Des Moines.

12. Reported as *Planorbis armigerus* from Missouri by Swallow (*l.c.*).

13. Reported as "rare and local" by Professor Witter, U. S. Geol. Sur., Vol. XI, p. 471. It may be from modified loess.

14. Swallow (*l. c*) also reports a *Cyclas* from Missouri. This name was formerly applied to both *Pisidium* and *Sphærium*. Hambach (Bull. No. 1, Geol. Sur. of Mo., p. 82), who practically reproduces Swallow's list, omits this entirely.

15. In the U. S. Geol. Sur, Vol XI, p. 471, McGee reports the following species on authority of Professor Witter:

Unio ebenus Lea.

Unio ligamentinus Lam.

Unio rectus Lam.

Margaritana confragosa Say.

16. From Binney's Terrestrial Air-breathing Mollusks, Vol. V (except the last species). In most cases these are simply reported as "post-pleiocene," but several are specifically reported from Natchez Bluff. Most of the species belong wholly to the southern fauna, and all are terrestrial.

Only such "post-pleiocene" species as are not given in Table I are included in Table II.

17. It is possible that this is *P. strigosa cooperi* as given in Table 1. Mr. Binney, the veteran conchologist, at first pronounced our loess specimens *P. solitaria*, but upon a closer examination of Iowa specimens declared his inability to decide between that species and *P. strigosa cooperi*.

18. Reported from the "post-pleiocene' by Binney in Land and Fresh-water Shells of N. Am, part 3, p. 108. The species is strictly terrestrial and is now common in the southern states.

DEGRADATION OF LOESS.

J. E. TODD, VERMILLION, S. D.

One of the most difficult problems connected with the loess is to explain its blanket-like distribution, by which it appears to be continuous over high and low altitudes alike.

In southwestern Iowa and eastern Nebraska the altitude of its base or junction with the drift varies from 100 to 200 feet. As a rule its upper and lower surfaces are approximately parallel, the lower being less convex and frequently showing a culmination somewhat one side of that of the upper. And even occasionally there is a concavity in the lower corresponding to a convexity in the upper. There is sometimes trace of a washing of the surface of the underlying till, especially at medium levels, as shown by a line of gravel or sand. The position and character of the junction of the loess and drift at lower levels is not so often shown and is therefore little known.

The generally received opinion, I think, is that the drift was deeply eroded before the deposition of the loess. This view as we shall see only aggravates the difficulty of the problem. If the surface of the drift was very uneven, as at present, it is difficult to see how rivers, lakes, and winds could have deposited the loess as we find it. This will appear as we proceed to consider the solutions which have been presented and in some cases urged. These we will survey very briefly, as our time is short.

1. The Lacustrine theory was first suggested, and for a long time, for perhaps fifty years, was considered fairly satisfactory. It ran through various forms, from a semi-marine or estuarian origin on one hand to the result of small, local, often shifting lakes, on the other. The first was forbidden by the utter absence of marine forms of life, and the following objections lie more or less forcibly against all:

a. There is no trace of barriers sufficient to account for their existence.

b. There is no trace of beach deposits, either of ridges or shelves.

c. There is serious difficulty in accounting for the observed distribution of material, so uniform in thickness and character, in a currentless body of water. And if currents are postulated they would have tended to follow deeper valleys and would have differentiated the loess more than we find to be the case

2. The Æolian hypothesis, first suggested by Richthofen for the loess deposits of China 20 years ago, has had some distinguished advocates who have accepted it for similar formations elsewhere.

More commonly, however, it has been held as a supplemental theory.

The following objections lie against its general application:

a. It does not accord with the distribution of the loess in general, while it may explain its occurence at different levels, it does not explain its common occurrence on windward slopes, nor its greater thickness near streams on both sides alike.

b. It can not be harmonized with the frequent occurrence of coarse material in the loess, in some localities.

c. It does not explain the horizontal banding, and the flat areas on the same level which are frequently exhibited by the loess.

3. We may notice also an Aqueo-æolian theory which supposes, that streams were flowing at lower levels, sluggish and varying much in volume at different seasons, so that broad bars of fine material contributed dust and fine sand to the winds when the water was low, which was borne up and spread over the adjacent high lands.

There is little doubt that such a condition has existed often and has been somewhat efficient in many localities, but it is certainly inadequate for our main purpose. The objections against the preceding theory would be applicable here also, especially the extensive flat areas lying at nearly the same altitudes mentioned under *c.*

Before presenting our remaining theory we will call attention to certain facts connected with loess and loams generally. These facts relate to the properties of loess itself, and to its erosion as sometimes displayed. We must also consider underlying formations so far as they affect the problem.

1. The rigidity of loess. It consists chiefly of grains

of quartz. These are cemented by carbonates of lime and iron and chinked more or less with clay. It stands like a rock if it is kept dry throughout.

2. It is on the other hand very plastic when wet to a certain degree. Water, particularly if charged with a little carbonic acid, dissolves the cement, and the clay serves as a lubricant to the rounded quartz grains. We have only to notice the behavior of it when thrown from a well, or to mix a little of it with water to be impressed with this fact.

This property is further exhibited in roads passing through cuts in loess, and in the rapid wash from hills and hillsides after a continued rainy season. Two and three feet of sediment have been deposited on the flood plains of adjacent streams after a single flood.

3. The porosity of loess and loams generally is marked. Water is quickly absorbed in any direction, by capillary action. This has been often noted in it as a subsoil. It affords admirable under drainage and on the other hand furnishes moisture from below in time of drought.

This character tends to promote plasticity and to render that character more general. By promoting absorption it decreases much the surface erosion.

4. The easy and perfect recementation or "setting" of loess after being wet, or the sudden change from plasticity to rigidity.

When water mixes with loess as sometimes on a side hill after soaking rains, or in sudden rainfall, it flows down, covering the surface below, and accumulating as a talus, and as soon as the water has soaked out of it, it is as firm and solid as the original loess. It may be almost impossible to show that it is a secondary formation except by inference from its relations, unless there be some fragment of plant, or shell, or position of concretions, or distribution of color to reveal the fact.

5. The vertical cleavage or column structure of the loess is a well recognized feature which has an important bearing on our subject. Several things, probably aid in producing this. The lateral shrinking in drying, the prevalent vertical direction of the roots of plants, and the formation of light faults by the unequal settling of different portions because of the plasticity of its lower portions, or of underlying clays or sands, are some of the more important.

As illustrations of this property we may refer to the way in

which we frequently find half way up a steep slope, epecially at the end of a spur running out toward a bottom land, a vertical cliff 10, 15, 25 or 50 feet in height. Also the irregularly terraced appearance which steep bluffs often show. From excavations in such bluffs I have noted that these are caused by a succession of nearly parallel faults running with strike of the slope which extend vertically through the dry, rigid portion of the loess to the moist lower layers, or to the drift clays below. They might be compared to crevasses in a glacial rapid.

This same property appears often in the sides of canyon-like ravines. In fact, the cutting back of a ravine is first due to the concentration of water in a depression in the lower surface of the loess, which escapes as a spring. This washes away the buttressing or enclosing material, the plastic loess escapes, the superincumbent mass settles down, becomes in turn moistened, plastic and washes away, and the process is repeated backward, following the vein of water. The sides also recede until their base has risen above the plastic effect of the water. But wet weather may further widen the canyon or cause it to throw out branches. The vertical cleavage and inherent rigidity of the dry loam cause it to stand indefinitely, while the underlying drift clay is being eroded. In a dry climate this stage might continue long, as it occurs to-day in similar formations in central Nebraska and Dakota.

To understand still better the origin of the wide vertical range of the loess, we need also to study somewhat the underlying formations. The most prevalent underlying formation of the loess in the Missouri valley is bowlder clay or till. This, though quite impervious, is usually traversed by oblique seams which cross each other, dividing the mass into polygonal blocks. These seams are followed more or less by infiltrating water.

There is without doubt more or less motion along these seams, in fact they are not unlikely due to strains produced by gravity upon the mass, or else by contractions caused by consolidation or drying. Moreover, the upper portions of this till are often quite easily rendered plastic by standing water.

Again, below the bowlder clay, which varies much in thickness and is sometimes subdivided, there is usually a layer of sand several feet in thickness. This, if exposed by the formation of ravines becomes a very unstable foundation and the

suberincumbent till and loess are let down bodily. Much of southeastern Nebraska seems to owe much of its roughness to these relations.

We are now fairly prepared to consider a theory to account for the problematic conditions indicated at the outset. I present it for your criticism. If I mistake not it will explain much, if not all, of the difficulties found.

We may suppose that the preglacial surface was uneven as in unglaciated areas generally. The advance of glaciers spread over it a blanket of bowlder clay, and left a surface similar to that inside of the Wisconsin moraine.

Upon this was spread by the flooded streams flowing from the melting ice sheet, either of the same, or some subsequent epoch of the ice age, and also by streams burdened with Tertiary silts and clays from the west, the sheet or succession of sheets of loess. At this stage the surface of eastern Nebraska, western Iowa and northern Missouri, was a silt-covered plain similar to that of the lower Mississippi at present. Possibly more uneven and more sloping. We can not conceive that deep rivers were the rule in this work but shallow overburdened streams more like the Platte of the present day, or the Hoang-Ho of China.

As the amount of water declined the channels would become more contracted as in a low water stage. The beginning of a northward differential elevation and a not improbable lowering of base level by the change in the course of the Missouri river, as the writer indicated in his Missouri report, may have begun a rapid trenching of the water-logged deposits.

In such conditions the erosion of valleys, we may suppose, went on much more rapidly than later, because of copious springs and great plasticity of the deposits.

As the drift and loess dried out there would be a relocation or redevelopment of the preglacial valleys, so that the post-glacial streams would approximately correspond to the pre-glacial, as has been pointed out by McGee and others.

The first erosion was probably largely by ravines, cutting down sooner or later to the underlying till and drawing off the surplus waters from the loess by springs. Here different suppositions may be considered.

If the dryness of the climate was sufficient to render the loess rigid, the springs and streams may have had fair opportunity to erode the drift, not only by corrasion, but by sapping

and undermining. It is not difficult to suppose that the appearance at that stage may have been not very unlike what is now seen in the "bad lands" of South Dakota, where rigid loams over-lie firm clays or rocks.

There may have been successive local base levels, each having its labyrinthine ravines, alluvial fans, and terraces.

If, on the contrary, there was much rainfall, so as to keep much of the loess plastic, there would be very low or no abrupt banks, but a general slow mud flow more or less rapid down the slopes. In such a case the early topography would have been a succession of flat upland and sag-like valleys with sides gently sloping or marked with landslides of greater or less extent.

In time the valleys would reach their lower base-level, the loose deposits would become more perfectly drained, the breaks would be gradually worn off by erosion though some stand as shoulders on the hillsides to the present time, and the region gradually put on its present aspect.

Another circumstance in the process, though probably exceptional, should not be omitted. A ravine may have become dammed by a landslide in its lower course, and the portion above may have been deeply filled with accumulations from the sides and wash from above. Subsequently, the barrier which may have itself disintegrated and been recemented, so as to appear a part of the original banks, is cut through and the ravine again works back over its original course.

If vegetation had accumulated in the bottom, a pseudo-forest bed may be thus formed. I examined a case of this sort in Mills county, Iowa, where cedars of considerable size had been buried sixty to eighty feet. The bottom of the ravine was yellow till, and the first thought was that it was an old land surface under the loess, but other facts, particularly the roots of one much higher up, showed that this growth was long subsequent to the original deposition of that formation.

It should be remembered that this theory is intended to have special application to the widest and probably oldest loess deposit. Some of the lower and more conspicuous are evidently of much later date. They are simply heavy silt deposits capping high terraces of deposition along the principal streams.

With this incomplete presentation I leave the theory for your criticism and hope that portions of it, at least, may be found of assistance in further investigation.

GEOGRAPHIC DEVELOPMENT OF THE CRIMEA.

BY CHARLES R. KEYES.

(Abstract.)

A year ago I attempted to emphasize the importance of having definite and absolute datum-planes for purposes of exact geological correlation, and I endeavored to show that stratigraphic unconformities have a far greater significance than is usually ascribed to them, especially when viewed in the light of modern physiographic principles. The latter not only imply the recognition of peneplains, or stages of approximate base-level of the land surface, but also in the sea areas the equivalent representatives in certain deposited materials. The cause inducing the new cycle of deposition being the same as that which produces mountains, the method of stratigraphical correlation based upon it was termed orotaxis, or classification of geological formations by mountain development.

In general, the relations of erosion and deposition, and of a grade-plain, or peneplain, and the great planes of sedimentation are about as follows (figure 1):

Figure 1. Relation of Grade Plain and Great Plane of Sedimentation.

As a rule the phenomena thus represented can only be made out clearly after a careful examination of the geological features over a very considerable region. The unconformity is of very frequent occurrence, and its equivalent representative of strata is equally often observable, but the practical correlation

of the two is fully established only in a few cases. One of the most notable instances that we have near us is in the coal measures of the Mississippi basin. A section north and south from the Minnesota line to west-central Arkansas is indicated below (figure 2):

Figure 2. North and South Section of Coal Measures of the Western Interior Basin.

Another, in which the old grade-plain is still unburied is believed to be found in the southern United States in which the Cretaceous, or early Tertiary, peneplain passes under the deposits of the Mississippi embayment (figure 3):

Figure 3. Structure of the Mississippi Embayment.

It is, however, to some other excellent displays of similar features that attention is especially called at this time, sections on the north shore of the Black sea, that have been recently noted.

The Crimea is a peninsula about one-half of the size of Iowa. At the south its surface rises abruptly from the sea to a height of over 4,000 feet, and then slopes gently down to the northern border, which is nearly at sea level. From almost any commanding point the general upland plain is distinctly marked, rising gradually to the southward to the top of the mountains of the Tauric chain. The peneplain is of Tertiary age. At a comparatively recent date it has been elevated to its present position. The new cycle of erosion that has begun has brought out into bold relief the hard layers which, with the intervening soft beds, had been previously tilted and bevelled. The result has been to produce a remarkable step and platform topography—the Cuesta relief of Hill. At Bakhtchisarai, forty miles northwest of Sevastopol, for example, a profound system of transverse valleys has been opened out, the one side having almost perpendicular cliffs over 500 feet high. The

general section north to south is represented in the subjoined cut (figure 4):

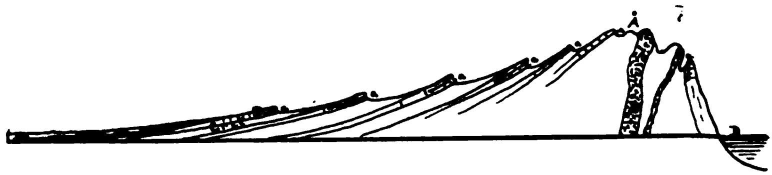


Figure 4. North and South Section of the Crimea.

In another direction, that is parallel to the shore and the long axis of the Black sea, the section appears as in the sketch below (figure 5), in which the old peneplain surface (*A–C*)

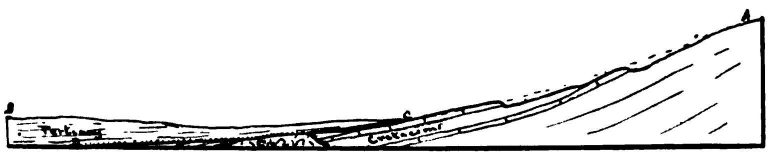


Figure 5. East and West Section of a Part of the Crimea.

seems to pass beneath the Tertiary deposits to (*D*) where it disappears below sea level. The Cretaceous eruptives (*C*) all have the appearance of being completely planed off. The distance represented by the section is fully a dozen miles, and it is all plainly visible from the sea at one time.

The region was peneplained in early Tertiary times, and then uplifted, with a maximum uprising near the present shoreline. This peneplain still retains numerous traces of its existence. With the uplifting was inaugurated the present cycle of erosion which has been somewhat accelerated by very late elevation. The dry climate has prevented a rapid softening of the relief.

CARBONIFEROUS FORMATIONS OF THE OZARK REGION.

BY CHARLES R. KEYES.

The term Ozark, as now generally understood, applies to all the broad dome-shaped and mountaineous area, lying in southern Missouri and northern Arkansas chiefly, and extending from the Red to the Missouri river, and from the Mississippi to the Neosho. In this sense the name is used in the present connection. For a long time the Ozark uplift remained a region about which less was known geologically, than perhaps any other part of the North American continent. Of recent years, however, so many new facts have been obtained concerning the formations of the northern part of the area that a very complete and satisfactory classification of the deposits for the whole of that region is now capable of being made out. This is particularly the case with those strata known to be of Carboniferous age.

In the southern part of the region, in Arkansas, little comparison was made with the sections of other regions, and consequently an entirely distinct grouping of the beds was adopted, one that was only in a very general way comparable to that in the north. Although much work had been done in the state mentioned, no satisfactory parallelism of the formations of the two districts was brought out. Within the past two years, however, direct comparisons have shown clearly that the geological sections of the Carboniferous formations of the entire Ozark region are essentially the same. The importance of this determination over so large a region is obvious.

The formations, which may be regarded as typically developed in Missouri, are fully described in the recent reports of the Missouri geological survey, and while no further reference need be made to them in this place they will be tabulated later. As already intimated, there has been in Arkansas an entirely

new set of names applied to the formations, with only vague attempts to indicate their equivalents elsewhere. About the only formation that was correlated with any degree of certainty with the northern section was the Boone chert, which was thought to represent, in part at least, the Burlington limestone. A short time ago* the typical Kaskaskia limestone was recognized in northwestern Arkansas, and indications of the St. Louis division near by in Missouri. Farther eastward, on the branches of White river, in the last named state, the Kinderhook had been determined; so that all four subdivisions of the Mississippian series were at last recognized for this district as clearly as these formations had been farther north. In addition, the productive coal measures (Des Moines series) were found to be present. The relations of these divisions to those of the Arkansas geologists farther south was thus easily determined.

Up to the beginning of the present year the only part of the Ozark region in which the Carboniferous formations remained uncorrelated with the typical sections was in northeastern Arkansas, in the Batesville district. Within the past few months Weller† has announced the results of his work here. He has brought forth abundant evidence to show that the formations in the vicinity of Batesville are capable of the same subdivision and are as clearly defined as in the more typical locality along the Mississippi river. His correlation of the Arkansas formations are given in the table.

Thus the exact parallelism of the Lower Carboniferous (Mississippian) formations around the whole of the Ozark dome may be regarded as established as essentially similar. Why this is so, and why it should be expected, will be referred to more specifically in another place.

In Arkansas the Carboniferous above the Mississippian series has also remained without any exact determination as to position in the general section of the Continental Interior, but in a broad way it has been thought to be equivalent to the combined upper and lower coal measures of Missouri and Kansas, or about what has been more recently called the Des Moines and Missourian series. The alleged enormous thickness of the coal measures of the southern Ozarks—1,000‡ to 2,400§ feet has

*American Geologist, Vol. XVI, p. 86. 1895.

†Trans. New York Acad. Sci., Vol. XVI, p. 251, 1897.

‡Winslow: Bul. Geol. Soc., America, Vol. II, p. 225, 1891.

§Branner: Am. Jour. Sci. (4), Vol. II, p. 235, 1896.

probably led to a misinterpretation of the real conditions that prevailed during the period of their deposition. The purely paleontological evidence, though somewhat meager, set forth by Smith,* was intended by him to strengthen the view stated above, that the Arkansas coal measures are the representatives of the commonly recognized upper and lower divisions of the Mississippi basin, taken together. However, a careful consideration of the fossils noticed and a comparison with those of other districts appear rather to indicate that, in Arkansas, only the lower coal measures, or Des Moines series, is really present. This is also in accordance with the results of various other lines of investigation in the Ozark region. The correlation of the Arkansas coal measures, with its great thickness, and the Des Moines series of Missouri and Kansas, with a thickness of only one-fourth of the first named, is fully explained elsewhere. In a word, the shore-line during the latter part of the Mississippian epoch was approximately along the present axis of the Ozark uplift. North of that line erosion of the land was taking place, now indicated by the great unconformity of the base of the coal measures throughout the greater part of the Mississippi basin. South of the line, shore deposits were being laid down on a slowly sinking coast, within that district, no secession of sedimentation.

The Missourian series may, therefore, be regarded as not being represented in any part of the Ozark dome, unless possibly in some parts of Indian territory, where the Ouchita range extends westward.

The following is, then, a summary of the Carboniferous for mations of the Ozarks and of their local equivalents:

*Proc. American Philos. Soc, Vol. XXXV, pp. 213-265, 1896.

CORRELATION OF CARBONIFEROUS FORMATIONS OF THE OZARKS.

	GENERAL SECTION.	EASTERN MISSOURI.	NORTHEASTERN ARKANSAS *Weller.*	SOUTHWEST MISSOURI AND KANSAS.	NORTHWEST ARKANSAS *Branner et al*
Mo.	Bethany.	Absent.	Absent.	Absent.	
Des Moines.	Pleasanton.	Absent.	Absent	Pleasanton sh.	Pleasanton?
	Henrietta.	Absent.	Absent.	Henrietta li	Kessler li. / —— shales
	Cherokee.	Cherokee sh.	Absent	Cherokee sh.	
Mississippian.	Kaskaskia...	"Chester" sh / Kaskaskia li. / Aux Vases ss.	Barton Gr. / Batesville ss.	Kaskaskia li.	Pentremital li. / Archimedes li. / Marshall sh.
	St. Louis. ..	Ste. Genevieve li. / St. Louis li	Spring Creek li.	Absent? / St Louis sh?	Batesville ss / Fayetteville sh.
	Augusta.	Warsaw sh. / Keokuk li. / Burlington li.	Boone chert.	Keokuk li. / Burlington li	Boone chert.
	Kinderhook.	Chouteau li.	St. Joe marble. / Sycamore ss	Chouteau li.	St. Joe li.

SOME GEOLOGICAL FORMATIONS OF THE CAP-AU-GRES UPLIFT.

BY CHARLES R. KEYES.

Cap au Gres is a name that was given by the early French voyageurs to a prominent sandstone headland rising from the east side of the Mississippi river a dozen miles above the mouth of the Illinois. The point is of special interest geologically on account of having, side by side, beds of the earliest and latest Paleozoic. The sandstone is Cambrian in age and the contiguous limestone middle Carboniferous. The cliff marks the position of the most profound dislocation, or fault, known in the Mississippi valley. Near the line of the slip the horizontal strata are abruptly bent upward at high angles, as much as 80 degrees, immediately against the fault plane. (See plates I and II). Hence it is that within the very short horizontal distance of less than a mile the greater part of the entire Paleozoic section of the region is well displayed.

The fault has been traced northwestwardly for a distance of fully fifty miles and doubtless extends four to five times that distance further. For a considerable distance on either side of it an extensive vertical section is shown. In Pike and Lincoln counties, Missouri, the detailed succession and areal extent of the various formations have been recently made out with a degree of exactness that has not yet been attained in any other locality in the whole interior basin. For this reason particular attention is directed at this time to this region. The complete section represented is as follows:

GENERAL GEOLOGICAL SECTION NEAR CAP AU GRES.

SYSTEM.	SERIES.	STAGE.	THICKNESS—FEET.
Pleistocene.		Drift and loess.	30
Carboniferous.	Des Moines	Cherokee sh.	50
	Mississippian	St Louis li. Augusta li. Chouteau li.	80 150 30
Devonian.		Hannibal sh. Louisiana li Grassy Creek sh. Callaway? li	75 50 30 20
Silurian.		Bowling Green li †Noix Oolite.	25 7
Ordovician.		Buffalo sh. McCune li. Bryant li. Folley li Cap-au-Gres ss.	60 25 140 65 125
Cambrian.		Winfield dolomite.	40

In the nomenclature of the geological formations a number of new names appear. This has been rendered necessary on account of the fact that the various beds thus christened cannot be compared directly with the formations of similar age in other parts of the Mississippi valley. The disturbance which the strata have undergone has brought up to the surface in a very limited area the rocks of the earliest half of the Paleozoic in the very midst of those of the latter part of the same era. Thus older strata rise in a long monocline, and are abruptly cut off on the south by the great Cap-au-Gres fault. The layers, of

course, are bevelled or planed off to conform with the present surface of the region.

The nearest exposures of rocks of the same age are in the Ozark region, and there also are the closest stratigraphical equivalents. Other localities are no nearer than northeastern Iowa.

Winfield Limestone.—This formation is exposed only in the immediate vicinity of the Cap-au-Gres fault. Its greatest exposed thickness is half a mile north of Winfield, in Lincoln county, Missouri, where it rises forty feet above the floodplain of the Mississippi river. Worthen did not observe it on the Illinois side of the river, five miles away, but a foot or two of it is well shown there in times of very low water, when it appears under the great massive sandstone which forms the bluffs at this point.

In lithological character the rock is a deep buff, somewhat earthy, magnesian limestone, rather heavily bedded, and containing some sandy material. It is apparently destitute of organic remains. Being the lowest bed exposed along the Mississippi between the Missouri river and northern Iowa, it is of special interest; while within the area of exposure its position is clearly indicated as immediately underneath the great Cap-au-Gres sandstone.

Cap-au-Gres Sandstone—As typically developed at Cap-au-Gres, the formation consists of a very massive, fine-grained, soft sandrock, homogeneous in texture and white or yellowish in color. Directly at the headland no strata rest upon it, but a mile upstream, owing to the pronounced northward dip, the overlying limestone begins to appear in the top of the cliff. From the headland up to the ferry landing, a distance of perhaps two miles, the sandstone forms high perpendicular and castellated cliffs, which rise directly from the water's edge (plate III). On the Missouri side of the Mississippi it forms the middle and lower parts of the steep bluffs north of Winfield. Fifteen miles northwest of the last named place, near the line of the fault, it appears also to be exposed in the beds of two small creeks. Worthen, in mentionirg this formation, correlated it with the St. Peter sandstone of northern Illinois, but that formation is probably not represented so far south. The Missouri geologists referred it to the Saccharoidal sandstone. It is regarded as the base of the Silurian.

Folley Limestone.—The name is derived from the little station of Folley, north of Winfield, in Lincoln county, Missouri, where in the west bluffs of the Mississippi river the best exposures occur. It crops out on both sides of Sandy creek, southwest of the town, and on the hill-tops south of that stream. There are also good exposures of the limestone on the Illinois side of the river.

This formation is a light yellow, rather heavily bedded, magnesian limestone, containing few fossils. Locally, thin shale and sandy bands are present. The early Missouri geologists regarded the beds included within the limits of the Folley horizon as representing a part of the first magnesian limestone and all the Trenton. Worthen, on the other hand, referred the beds under consideration to the lower Trenton.

Bryant Limestone is light blue or gray in color, rather thinly bedded, with more or less numerous shale partings. It is compact, somewhat fossiliferous, and presents a marked contrast to both the underlying and overlying dolomitic limestones. The thickness is from 125 to 150 feet. Its most characteristic exposures are found on Bryant creek, in the northeastern part of Lincoln county, Missouri. It forms the surface rock over a large area north of the fault-line, but to the northward, in Pike county, it becomes gradually covered, first by outliers, and then by the main body of newer layers. In the main, it has close relations with the so-called Trenton of other parts of the upper Mississippi valley.

McCune Limestone.—The upper 25 or 30 feet of what has been heretofore called the Trenton in northeastern Missouri, is a massive, buff, dolomitic limestone, carrying abundant fossils, usually large characteristic forms. The best exposures of the formation are on Peno creek, near McCune station, a dozen miles west of Louisiana, in Pike county, Missouri. It also outcrops in many localities in the southern part of the same county, and in the northern part of Lincoln county, adjoining on the south.

Buffalo Shales have heretofore been referred to the Hudson, and have been generally considered as the representatives of the Maquoketa shales of northeastern Iowa, and the Cincinnati shales of Ohio. In lithological characters and in fossil contents they closely approach these supposed equivalents in the states mentioned, but at the same time they present some very notable differences. It is also somewhat doubtful whether they

occupy the same stratigraphical position, and this only a very careful study will determine. The shales as brought up to the surface by the disturbance which was somewhat relieved by the great fault, are well exposed on Buffalo and many of the other creeks in the vicinity of Louisiana, where over 40 feet are shown above the water level of the Mississippi river. The fossils found in these shales have been listed in another place. The shales are regarded as forming the uppermost member of the Ordovician of this region.

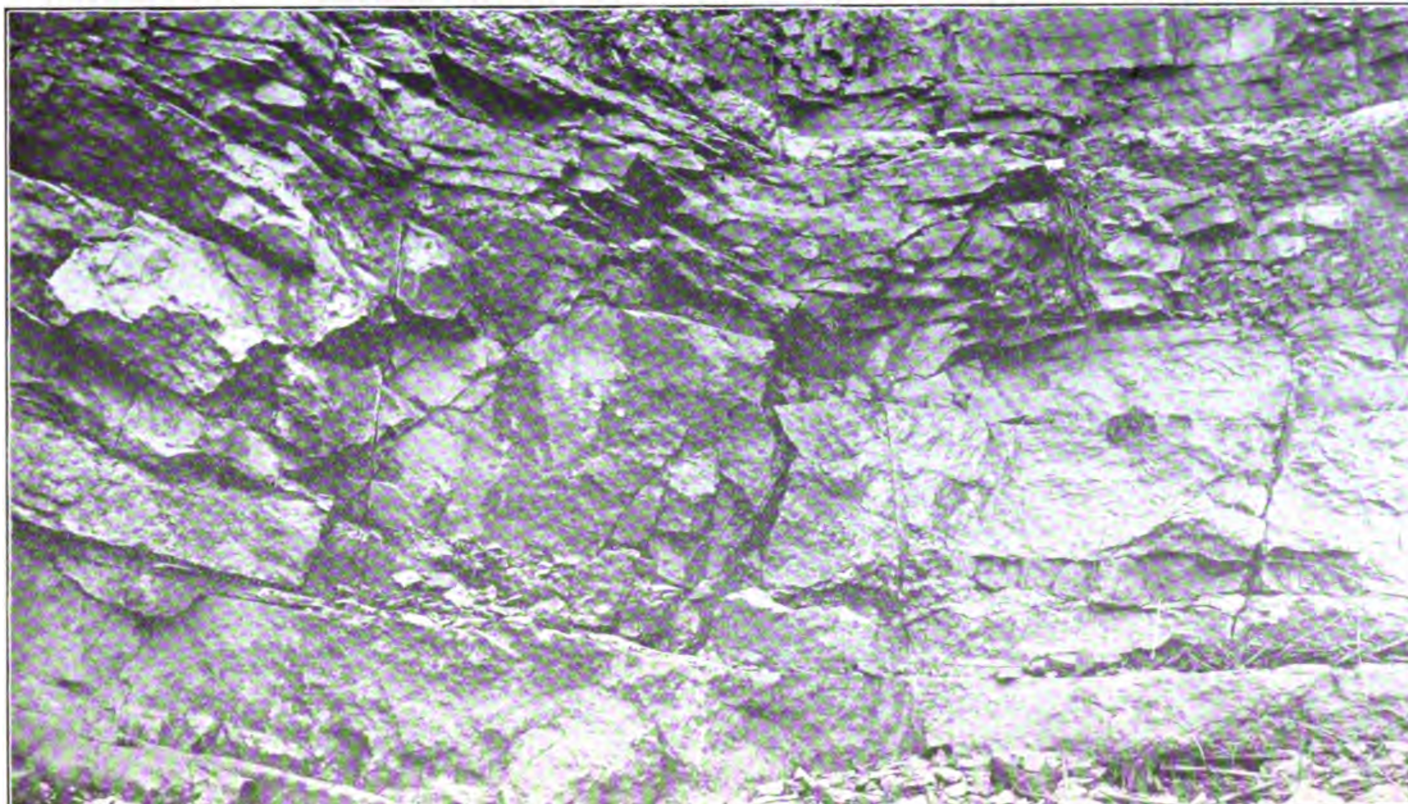
Noix Oolite.—Immediately above the Ordovician shales at Louisiana and in the vicinity, is a very white, massive oolite, containing numerous fossils and having a thickness of four to seven feet and upwards. Its areal distribution is over 100 square miles. It is best exposed, perhaps, in the immediate neighborhood of Louisiana in the valley of Noix creek and along the bluffs of the Mississippi river. From this locality its extends westward and southward, reaching the northern part of Lincoln county, Missouri, where it occurs in isolated areas in the tops of the hills. It also crops out below Louisiana in the east bluffs of the Mississippi, near Hamburg in Calhoun county, Illinois.

The character and variety of the fossils contained is indicated in the list of fossils given recently in a previous volume of the Academy's proceedings.

Bowling Green Limestone.—Closely associated with the oolite on Noix creek, is a buff, massive, magnesian limestone. At Louisiana it is only four to five feet thick, but this measurement rapidly increases westward and southwestward to twenty-five or thirty feet. Near Bowling Green, twelve miles southwest of Louisiana, it is well displayed to its full thickness, and at the same time shows all its other distinctive characters. In Calhoun county, Illinois, it yields a characteristic fauna, and attains a maximum thickness of thirty feet. The Noix oolite and the Bowling Green limestone together may be regarded approximately as equivalent to the so-called Niagara of the upper Mississippi basin, and is the only representative of the whole Silurian, or upper Silurian of the earlier geologists.

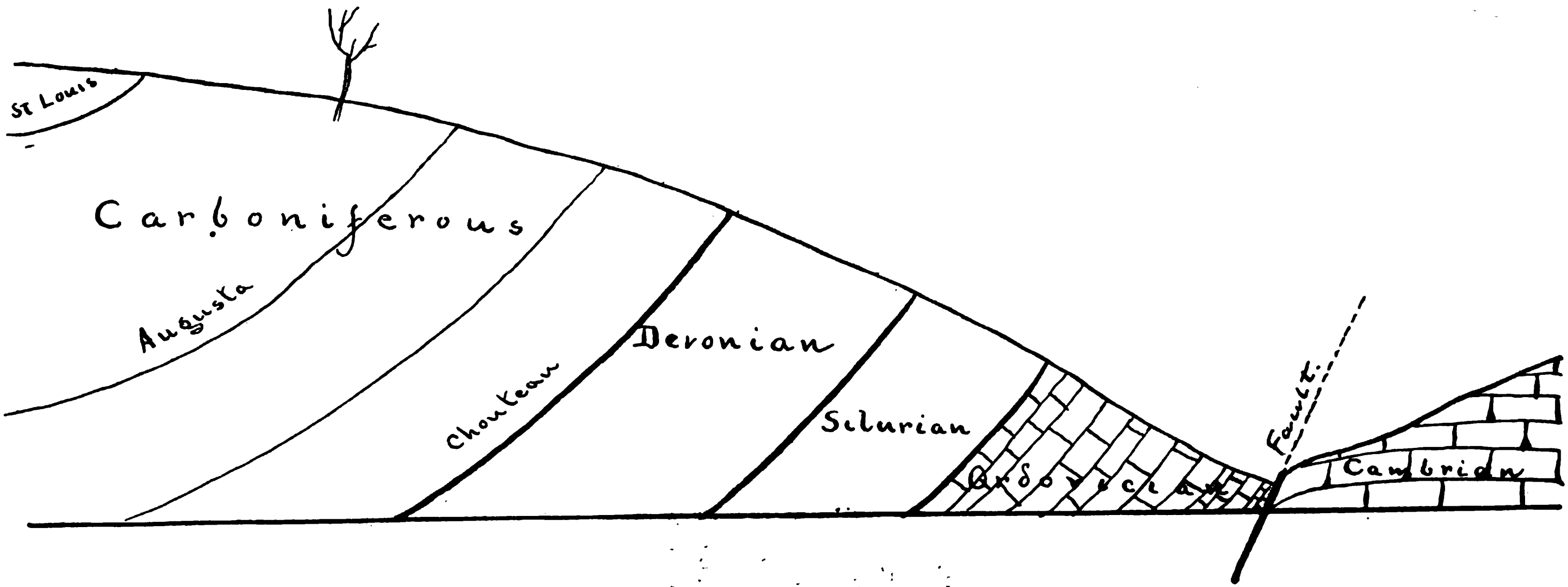
Callaway? Limestone.—On the north margin of the Ozark uplift the lower Devonian beds, that is, the layers lying between the Silurian limestone (Bowling Green) and the Louisiana limestone, are represented by highly fossiliferous strata, limestone below and shale above. In central Missouri, in Callaway

THE CAP AU GRES FAULT, WINFIELD, MO.



Horizontal St. Louis Limestone Beds. being bent upward, near the Cap au Gres Fault.

Cap au Gres andstone, east bluff of the Mississippi River below Cap au Gres Ferry.



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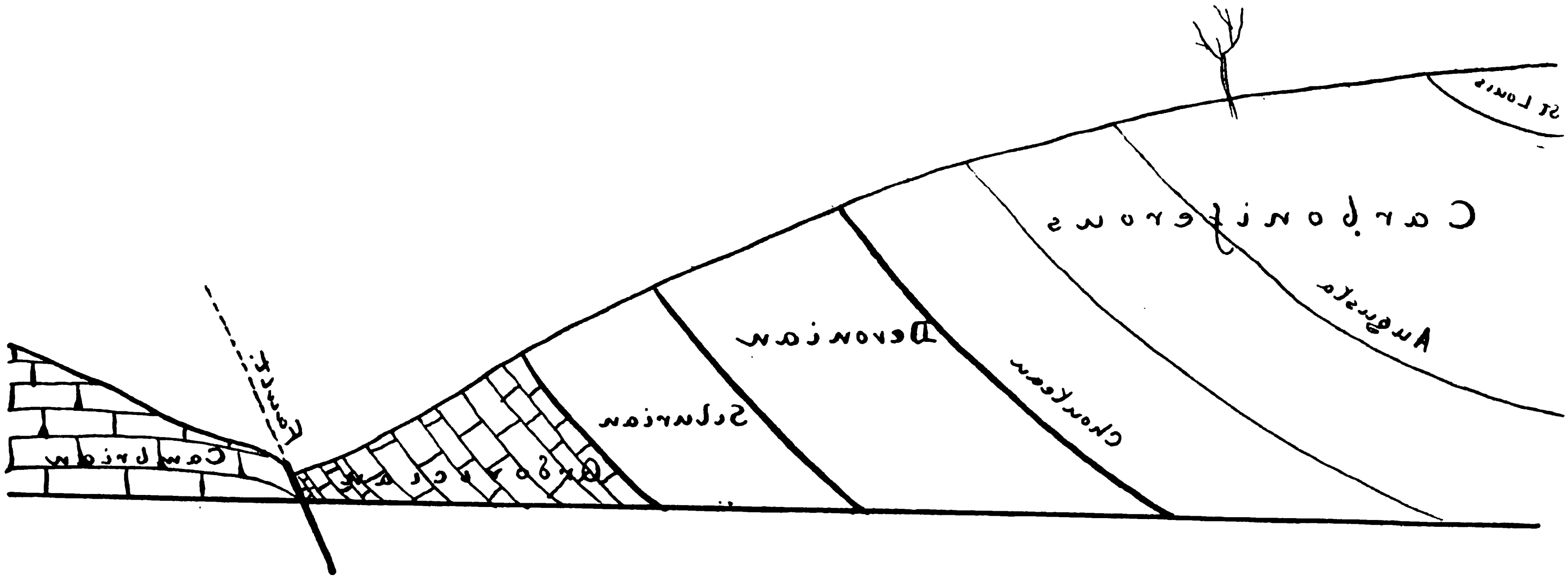

CAP AU GRES FAULT.

and Montgomery counties, the basal formation of the Devonian was regarded as best displayed, and it was then denominated the Callaway limestone. From the typical locality it appears to get thinner northeasterly, and when it reaches the surface again, on account of the stratigraphical disturbance in Lincoln and Pike counties, it is not more than twenty-five feet thick. Still farther northward, in the vicinity of Louisiana, it thins out altogether, and at the standard sections at the city itself it is wholly wanting.

While this formation in the Callaway region presents some differences, it is believed that it is properly paralleled with that of the Cap au Gres region, although in the present connection there is some doubt whether the latter should be properly called the Callaway. In the region under consideration the typical "Western Hamilton" fauna is contained in this formation, the same species that are found farther north in Iowa.

Grassy Creek Shales.—Immediately beneath the well defined Louisiana limestone, in the vicinity of the town of Louisiana, there are about six feet of black and green shales carrying a characteristically Devonian fish fauna. Ten miles west of Grassy creek, these shales attain a thickness of thirty feet, but southward they thin out completely before the limits of Pike county are reached.

Louisiana Limestone.—This and the overlying Hannibal shales have long been regarded as forming a portion of the Kinderhook stage of the Carboniferous. The evidence for now considering these as belonging to the Devonian was given in the volume of the Academy's proceedings published last year.

THE INTERGLACIAL DEPOSITS OF NORTHEASTERN IOWA.

BY SAMUEL CALVIN.

The interglacial deposits of northeastern Iowa embrace (1) the peat and forest bed which has been known to well diggers since the early settlement of the region, but which, for this region, was first brought prominently to the attention of science by the writings of McGee, and (2) the Buchanan gravels of Calvin. These deposits represent two distinct horizons in the glacial series. The Pleistocene formations of northeastern Iowa have received more or less attention from geologists since first the region was traversed by Owen. The great Iowan bowlders of this region impressed Owen as they have impressed every intelligent observer since, but he believed that these enormous masses of granite could only have been transported to their present position by floating ice "drifted by currents setting in from the north, before the land emerged from the ocean."*

Hall, while state geologist of Iowa, seems to have devoted his attention almost exclusively to the indurated rocks and their fossil contents, but A. H. Worthen, who was then acting as assistant on the Iowa survey, discussed briefly the drift of some of the counties which he examined,† though he offered no explanation of the phenomena.

Dr. C. A. White‡ was the first geologist to consider the drift phenomena of Iowa at any great length. He recognized the glacial origin of the deposits, and referred some of the materials to their true sources in granitic and quartzitic ledges of regions lying to the northward. The time had not yet come, however, for recognizing the complex nature of the Pleistocene deposits of

*Rept. of a Geological Reconnoissance, etc., p. 69. Ordered printed July 3, 1848. Rept. of a Geol. Sur. of Wisconsin, Iowa, and Minnesota. p. 144. Philadelphia, 1852.

†Rept. on the Geol, Sur. of the State of Iowa, by James Hall and J. D. Whitney, pp. 187, 200, 210, and 221, 1858.

‡Rept. on the Geol. Sur. of the State of Iowa, by Charles A. White, M.D., Vol. I, pp. 82-102. Des Moines, 1870.

Iowa, and hence the numerous problems with which more recent investigators have been chiefly concerned, were not considered.

It remained for McGee, from 1875 to 1880, to introduce methods of investigation that finally furnished the key to the interpretation of the complex system of deposits embraced in the Pleistocene of this part of Iowa.* He pointed out that the drift was certainly dual and not single as had been previously supposed. He insisted that the interval between the two glacial invasions was one of enormous length, going so far in one of his earlier papers as to claim that the older drift might probably be Miocene Tertiary in age, and that the interval which he so clearly recognized might represent the whole of the Pliocene. He took account of the forest bed which he regarded as lying between the earlier and later drift—the lower and upper till, as he finally called them. He furnished the criteria for discriminating the two till sheets by their color and contents. He led the way to a rational and satisfactory classification of the Pleistocene beds of the Mississippi valley. His insight and farsight in the presence of such complex problems in an unworked field betokens genius of a high order.

McGee looked upon the forest bed as the plane of division between his lower and upper till, but later investigators following the lines which he pointed out, have reached the conclusion that his lower till embraces two distinct drift sheets, and that it is between these two that the forest bed invariably lies. Thus there are three drift sheets in northeastern Iowa, and in the recent literature referring to Pleistocene geology they are known respectively as sub Aftonian or Albertan, Kansan and Iowan.

No forest material has been observed between the Kansan and the Iowan, but in this situation there occur extensive beds of stratified sands and gravels.

The forest bed between the first and second drift sheets is frequently accompanied by beds of peat that range from one inch or less to three or four feet in thickness, and cover areas of considerable extent. When peat is absent there is often evidence of an ancient soil, humus-stained and weather-stained

*On the Relative Positions of the Forest Bed and Associated Drift Formations in Northeastern Iowa. Am. Jour. Sci., III, Vol. XV, pp 339-341, 1878.

On the complete series of the Superficial Geol. Formations in Northeastern Iowa. Proc. Am. As'n. Ad. Sci., Vol. XXVII, pp. 198-231, 1879.

See also The Pleistocene History of Northeastern Iowa, U S. Geol. Sur., Eleventh Ann. Rept., pp. 190-577. Wash., 1893.

as is the case with modern soils. This soil, peat and forest horizon is correlated with the Aftonian interglacial deposits of southwestern Iowa. It has been encountered in hundreds of wells in the northeastern part of the state, and it has been revealed in not a few instances in railway cuttings. The peat and forest bed in the great railway cut at Oelwein was discussed before this Academy* one year ago, and the description need not be repeated at this time. The relations of the beds in question, so far as relates to northeastern Iowa, may be very satisfactorily studied in the extensive reports on well sections in McGee's memoir on the Pleistocene deposits of northeastern Iowa, pages 515–590.

Buchanan Gravels.—Buchanan gravels were first recognized as a distinct interglacial deposit at the gravel pit of the Illinois Central railway in the northwest quarter of section 32, Byron township, Buchanan county, Iowa. The pit is located about four miles east of Independence. The exposure was described in a paper read to this Academy two years ago, and the paper, in addition to being published in the proceedings of the Academy, appeared in the American Geologist.† The beds to which the name was applied consist of stratified sands and gravels. The bedding is in places oblique, showing the action of strong currents, and scattered through the deposit are bowlders ranging up to 12 or 15 inches in diameter, suggesting the probable agency of floating ice. It is certain that a very large number of the bowlders have not been rolled or abraded, for they retain the facets and scratches due to glacial planing as perfectly as if they had never been disturbed after finishing their journey as part of the subglacial drift transported by the Kansan ice.

The materials making up the Buchanan gravel have been derived chiefly from northern sources, though fragments of fossiliferous limestone that has not been transported for any considerable distance are not rare. The materials furthermore have all the characteristics of the pebbles and bowlders that occur in the Kansan drift. A large proportion is dark colored greenstone, with a high percentage of the individual fragments planed and scored. Certain granites and representatives of other rock species are completely decayed, so that blocks a foot in diameter fall to pieces under a single blow of the hammer. Many that were thrown out in the bottom of the pit as too large

*Proceedings Iowa Academy of Sciences, Vol. IV, pp. 54-68, 1897.
†American Geologist, Vol. XVII, p. 76, Feb., 1896.

to be used as ballast have crumbled to fine sand under the action of the weather. Finally the gravel is exceedingly ferruginous in places, and is everywhere much stained and weathered, particularly near the top of the deposit, the weathered portion taking on a characteristic reddish-brown color.

At the typical locality the Buchanan gravel rests on blue till of Kansan age, and is overlain by a bed of Iowan till varying from two to eight feet in thickness. The Iowan drift, as is usual in this vicinity, contains very many large, light-colored granite bowlders. Some of these are perched on the very brink of the pit, some were undermined in taking out the gravel and have fallen to the bottom, others lie scattered in great numbers over the adjacent fields. Within a radius of one-fourth of a mile bowlders may be found ten, fifteen, or even twenty feet in diameter.

It is clear to the most casual observation that the gravel bed near Independence lies between two sheets of till, and that the weathering, oxidation and extensive decay that the materials have suffered constitute in some degree a measure of the great length of the interglacial period. At the time the gravels were first studied, only two years ago, remember, it was the current belief that the Pleistocene deposits of Iowa, except in the area occupied by the Wisconsin lobe, contained a record of two ice invasions, and of two only. Accordingly the Aftonian gravels and soil beds which had been previously observed in Union county, were assumed to lie between McGee's lower and upper till; and since the Buchanan gravels plainly occupied what seemed to be a similar position, they were first referred to the Aftonian stage. Our knowledge of Pleistocene geology has moved with tremendous strides during the past two years. A review of its progress would occupy more space than can be given to this paper. A few points, however, must be noted. First, Bain showed that the till overlying the Aftonian beds was Kansan, the lower till of McGee, and not the Iowan, or upper till as had been assumed. This observation rendered necessary a series of adjustments in views previously entertained. A new drift sheet was added to the glacial series of this region, and the Aftonian and Buchanan beds were shown to lie at different horizons. Before that adjustment Chamberlin* had published his classification of American glacial depos-

*Journal of Geology, Vol. III, p. 270, April-May, 1895.

The Great Ice Age, James Geikie, third edition, 1895, Chamberlain contributes the chapters on Glacial Phenomena in N. A., pp. 724-774.

its, which recognized the Kansan, Iowan and Wisconsin as the only glacial stages that had been worked out with any satisfactory degree of definiteness. It was in these publications that the Aftonian beds were referred to the interval between the Kansan and the Iowan. The adjustment following Bain's demonstration of the true position of the Aftonian left the Buchanan gravels as the only recognized deposit, so far published, representing this interval, and the term Buchanan offered itself as a convenient designation for the second interglacial stage. In the meantime Leverett* was pushing investigations on a sheet of till younger than the Kansan, but much older than the Iowan, and furnishing proof that the enormously long interval between the Kansan and Iowan ice invasions is represented not by one, but by three distinct stages of the glacial series. One of these stages, the Illinoian, is glacial, the other two interglacial. When, therefore, in 1896, Chamberlin† revised his classification of glacial deposits there were five drift sheets to be recognized in Iowa in place of three. The Aftonian beds were assigned their true place beneath the Kansan drift and the term Buchanan was used for the second interglacial interval.

The Buchanan gravels are connected genetically with the events immediately following, or intimately attending the withdrawal of the Kansan ice. The materials were evidently derived directly from the Kansan drift. So far as their deposition is concerned, they belong to the very beginning or initiation of the interglacial stage following the Kansan. They remained exposed and undisturbed, subject to all the changes incident to weathering, during the interval following the Kansan, during all the Illinoisan glacial stage, and during the interval that followed, until the invasion of the Iowan ice. At no point so far as yet known are they seen beneath the Illinoian drift. They are usually covered with Iowan drift within the area which this drift sheet occupies. For some distance outside the margin of the Iowan drift they are known to occur covered with loess.

The Buchanan gravels are much more generally and widely distributed than was at first supposed. They are known to underlie Iowan drift over thousands of acres in Buchanan county alone. A bed is extensively worked for road material near Winthrop. A still heavier bed is exposed a mile or two

*Leverett had recognized the Illinoian drift as the representative of a distinct glacial stage as early as 1894, but the fact was not published until 1896

†Jour. of Geol., Vol. IV, p. 874, October November, 1896.

east of Jesup. In the neighborhood of Rowley there are numerous pits, and well records show the beds to be continuous over an area of two or three miles in extent. An area of probably greater extent is known in the eastern part of Fairbank township. Along the sags followed by the prairie streams they are very common, having been laid down apparently along the courses of pre-Iowan valleys, which were only partly filled by the later Iowan drift. The broad swale followed by the south branch of the Maquoketa, in Madison township, and the similar swales in which flow Buffalo creek and Pine creek, in Buffalo and Byron townships, are all occupied by Buchanan gravel under a thin layer of Iowan drift.

These gravels are equally well developed in Delaware county. A very ferruginous bed, thirty feet in thickness, occurs just north of Earlville, and covers a large area of rather high ground. An area embracing some hundreds of acres, and occupying a low plain along Bear creek, near Dyersville, is underlain by gravels of the Buchanan stage. The thickness is unknown. The plain is covered with Iowan drift to a thickness of two or three feet, and is liberally sprinkled with large Iowan bowlders. Near Colesburg, in Delaware county, six or eight miles beyond the extreme eastern margin of the Iowan drift, there are several exposures of typical Buchanan gravels overlain by loess.

Buchanan gravels present two phases, an upland phase and a valley phase. They occur at all elevations, and some of the thickest, heaviest beds are found on the very highest points of land. The gravels of the upland phase are coarser, the proportions of sand being less, and the size of the pebbles themselves being larger, than are those found in the valleys. Bowlders, presumably transported by floating ice, are larger and more numerous in the upland phase than in the other. It is the upland phase that occurs at the typical locality in the Illinois central gravel pit. A heavy bed of the same type occurs a mile east of Independence, on the highest ridge between the Wapsipinicon and Buffalo creek. It is this same type that is found on the high ground north of Earlville, west of Winthrop and east of Jesup.

The valley phase of the gravels is well illustrated at the beds near Dyersville. These beds have been used extensively for ballast by the Great Western railway. Sand predominates. Cross-bedding is less common than on higher ground. The

pebbles rarely exceed three-fourths of an inch in diameter and the majority are not more than half an inch. Bowlders such as occur at the typical exposure are almost unknown. Beds of the same character form a broad terrace along the valley of the Wapsipinicon from Littleton to Independence, and are continued up every lateral valley for a distance of some miles. The greater abundance of sand, the regular bedding, the smaller size of the pebbles making up the gravelly portion of the deposit, and the scarcity of bowlders, differentiate the valley gravels from those occurring on the highlands. Furthermore the upland gravels are weather-stained and oxidized to a much greater depth than those found in the valleys, doubtless due to the fact that the coarser nature of the deposits offers greater facilities for the penetration of oxidizing and weathering agents. There is, however, a perfect intergradation of the two phases, and both are alike covered with a mantle of Iowan drift so far as they lie within the Iowan area.

The use of the term Buchanan as a name for an interglacial stage is open to criticism. It came into use tentatively before the recognition of the Illinoian drift, as a stage distinct from either Kansan or Iowan, had been published, and when the whole period of time between the retreat of the Kansan and invasion of the Iowan ice was supposed to be a single, uninterrupted, interglacial interval. It was first used in the precise sense in which the term Aftonian was originally used, and as a substitute for that term when it was shown that the Aftonian soils and gravels preceded the Kansan stage. Since the recognition of the Illinoian glacial stage the term has been used for the interval following the Kansan in publications by Chamberlin, Calvin and Scott. No great objection to its continued use can be urged. In fact it is much to be desired that names once introduced should remain undisturbed, but it may after all be a decided gain to Pleistocene geology to select a name for the interval between the Kansan and Illinoian from some locality where true interglacial deposits are clearly intercalated between the Kansan and Illinoian sheets of drift.

THE WEATHERED ZONE (SANGAMON) BETWEEN THE IOWAN LOESS AND ILLINOIAN TILL SHEET.

BY FRANK LEVERETT, DENMARK, IOWA.

PRELIMINARY STATEMENT.

Extent of Illinoian Till Sheet.—The Illinoian till sheet here discussed was formed by the Illinois glacial lobe in connection with the maximum extension of that lobe. It seems quite well established that a lobe on the east, which covered southeastern Indiana and southwestern Ohio, and extended a short distance into Kentucky, also had its culmination at the Illinoian stage of glaciation. Farther east the Wisconsin sheet in many places reaches the glacial boundary, but there are small tracts of drift older than the Wisconsin, lying outside its limits in eastern Ohio, northwestern and northeastern Pennsylvania, and northern New Jersey, which may prove to be of Illinoian age, though this is as yet, not established.

To the west of the Illinois glacial lobe there is a large area covering northern Missouri, southern Iowa, northeastern Kansas and eastern Nebraska, in which the upper sheet of till is older than the Illinoian, and is now referred to the Kansan stage of glaciation. The lobe which formed it is here referred to as the western lobe for it has as yet received no more definite name. The Illinoian sheet has not been recognized farther west than the limits of the Illinois glacial lobe. It seems probable, however, that it may be found in this western region, and possibly it occurs as far south as northern Iowa.

The Illinois glacial lobe at its maximum extension to the southwest, crossed the Mississippi and encroached a few miles on Iowa, in the district between Clinton and Ft. Madison. But farther north and south it appears to have terminated east of the Mississippi, except perhaps, for a few miles near St Louis, Mo. The southern border of this lobe apparently reached to

the glacial boundary from St. Louis eastward as indicated above. It is the southwestern border which claims our attention at this time, since the Illinois lobe there overrode to some extent the sheet of Kansan drift, formed by the western lobe, which covered much of Iowa, and portions of neighboring states.

The southwestern limits of the Illinoian drift is usually marked by a definite marginal ridge, or by chains of knolly and slightly ridged drift. Beginning at the south in Jersey county, Illinois, a few miles north of St. Louis, and tracing northward, the drift margin is found to follow the east side of the Illinois river in Jersey and Greene counties, and to carry only occasional knolls and low ridges. It crosses the Illinois in southeastern Pike county, and takes a northwest course coming to the Mississippi bluff near the line of Pike and Adams counties. It there enters a district which had been covered by the western lobe at the Kansan invasion. The Illinoian border takes a northward course along or near the east bluff of the Mississippi, through Adams and Hancock counties. A definite ridge twenty to forty feet high, is developed along much of the Illinoian margin in Pike and Adams counties, and as far north in Hancock county as a point opposite Keokuk, Iowa.

For a few miles above Keokuk the Mississippi river apparently follows nearly the border of the Illinoisan till sheet and no definite ridges are found. At the bend of the Mississippi below Ft. Madison, the Illinoian border crosses into Iowa. Its marginal ridge can be traced without difficulty from the vicinity of the Mississippi river bluff, south of West Point, Iowa, northward through Lee, southeastern Henry, northwestern Des Moines, and western Louisa counties, to the Iowa river at Columbus Junction. Its course there changes to the northeast and it can be traced diagonally across Muscatine county from its southwest to its northeast corner. It is traced with difficulty farther to the northeast because of concealment by a heavy sheet of loess which borders the Iowan till in Scott county, Iowa. It is known to extend as far north as Scott county, for the Illinoian till sheet has been observed in southern Scott county as far east as Davenport. The concealment by the Iowan loess is very great, not only in northern Scott county, Iowa, but also in Rock Island, Whiteside and Carroll counties, Ill. It becomes a difficult matter, therefore, to decide upon the posi-

tion of the margin of the Illinoian drift in any of these counties. It is also not fully decided whether it reaches to the border of the driftless area in Jo Daviess and northwestern Carroll counties, Ill., and in southwestern Wisconsin. The balance of probabilities, however, seem to favor its extending to the Driftless area.

The Illinoian till sheet overlaps, a few miles, the Kansan till sheet of the western lobe from the latitude of Hannibal, Mo., northward to the vicinity of the southern point of the Driftless area. In this region of overlap a weathered zone is developed between the Illinoian and Kansan till sheets at the level of the outlying Kansan surface as indicated below.

Introduction of the name Illinoian.—The tracing of this southwestern border of the Illinois lobe was begun by the writer in the autumn of 1892 and carried as far north as Hancock county, Illinois, that season No opportunity to continue the study was offered until the spring of 1894, when the mapping of the border was carried from Lee county, Iowa, northward to Scott county. The greater part of the data presented in this paper, and conclusive evidence of a long interval between the deposition of the till sheets now known as the Kansan and Illinoian, and also the evidence that the Illinoian is much older than the Iowan had been obtained as early as June, 1894. The writer then began to use the name Illinoian in correspondence, but it seemed best to defer its introduction into literature until opportunity had been afforded other geologists to examine it. In August, 1896, Prof. T. C. Chamberlin and Mr. H. F. Bain were conducted by the writer to some of the exposures in southeastern Iowa, which show the soil above and below the sheet formed by the Illinois lobe and each recognized the need for a distinctive name for this drift sheet. The name was accordingly soon introduced into geological literature by Pro fessor Chamberlin (1).

Other Interpretations.—At the ninth annual meeting of this academy, held in December, 1894, Mr. F. M. Fultz read a paper (2) in which the interpretation was presented that the ice lobes alternated in the occupancy of the district south of the Driftless area and that the latest occupancy was by the western lobe. The extension of the eastern lobe into Iowa had been inferred by him through the discovery of a bowlder of red jasper con-

(1) See editorial, Journal of Geology, October-November, 1896, pp. 872-876.

(2) Proceedings Iowa Academy of Sciences, Vol. II, 1895, pp. 209-212.

glomerate near Augusta, Iowa, which was apparently brought from north of Lake Huron. The evidence of an extension of the western lobe over the same district was found in eastward bearing striæ along the brow of the Mississippi bluff at points farther east than the site of this bowlder. Mr Fultz argued that if the striæ are not the product of the latest invasion they would not have been preserved in such an exposed situation. He also referred to some bowlder-strewn terraces in the Mississippi valley, at and above Keokuk as moraines, and correlated them with striæ as the product of the last ice invasion. The following summer Mr. Fultz and the writer, while examining some rock outcrops in Burlington, found a striated surface in which the bearing is westward This was evidently produced by the Illinois lobe, and as it is in a section about as exposed to obliteration by a subsequent invasion as those cited by Mr. Fultz in his paper, it became necessary to readjust the views set forth in that paper. This was done at the tenth meeting of the academy, in December, 1895, and the question of the relation of the two invasions was there left somewhat in doubt(1). The bowldery terrace interpreted by Mr. Fultz to be a terminal moraine has been examined by Prof. T. C. Chamberlin and Dr. H. F. Bain, as well as by myself, and to each of us it seems best explained as a residue of coarse material formed by stream excavation along the Mississippi valley subsequent to the last ice invasion. The evidence that the Illinois lobe was last on this ground seems conclusively shown in the relation of its till sheet to that of the sheet formed by the western lobe. The latter can be traced under the Illinoian sheet as indicated below. In addition to this evidence there is found an abandoned river channel in the district immediately west of the limits of the Illinoian drift which carried southward the drainage outside the Illinois ice lobe. The banks of this channel are well defined and the channel evidently has not been filled by the drift of any subsequent invasion.

Extent of the Iowan Loess.—By the term Iowan loess is meant that sheet of loess which connects at the north with the Iowan till sheet. A till sheet of Iowan age has been found in northern Illinois as well as in eastern Iowa, and it probably covers the greater part of the northern half of Illinois. It is, however, covered by the Wisconsin till sheet from Bureau county, Illinois, east and south. How much of Indiana and Ohio was covered

(1) Proceedings Iowa Acad. of Sciences, Vol. III, 1896, pp. 60-63.

by the Iowan ice invasion has not been determined. The Iowan till certainly does not extend as far south as the Wisconsin in those states. The loess forms a heavy deposit along the border of the Mississippi and Illinois valleys, but is comparatively thin in the region east of the Illinois, its average thickness being scarcely 10 feet. A silt tentatively correlated with the loess covers the Illinoian till sheet, wherever exposed outside the Wisconsin, from the Illinois river eastward to central Ohio. The Sangamon weathered zone between the loess and the Illinoian till sheet is found from central Ohio westward to southeastern Iowa, *i. e*, to the limits of the Illinoian till sheet. The Iowan loess extends also over the Kansan till sheet of southern Iowa and adjacent portions of Missouri, Kansas and Nebraska, but this loess is separated from the underlying till by a much longer interval than that between the loess and the Illinoian till sheet, an interval comprising two interglacial stages and one glacial stage.

Application of Buchanan.—At the tenth annual meeting of this Academy Prof. Samuel Calvin, after describing certain gravel deposits in northeastern Iowa, introduced the term Buchanan as a name for an interglacial stage following the Kansan (1), and made the following statement concerning the origin and age of the deposits:

"As to their origin the Buchanan gravels are made up of materials derived from the Kansan drift. As to age they must have been laid down in a body of water immediately behind the retreating edge of the Kansan ice."

Manifestly the deposition of the Buchanan gravels covers but a small part of the time between the Kansan retreat and the Iowan advance. Unless, therefore, the deposition and subsequent weathering both be included under this name it does not fill an interglacial stage. Were there no Illinoian glacial stage to break the continuity of interglacial conditions from the Kansan to the Iowan stage of glaciation it would not seem necessary to look for other terms. But in view of this glacial interruption there seems need for names which will stand for the weathered zones above and below the Illinoian till sheet. It is for this reason that the name Sangamon is here suggested for a weathered zone separating the Illinoian till from the overlying loess. In an accompanying paper the name Yarmouth is introduced for the weathered zone between the Illinoian and

(1) Proc. Iowa Acad. of Sciences, Vol. III, 1896, pp. 58-60.

Kansan till sheets. The name Buchanan may still have the significance given it by Professor Calvin; and if weathering be included may, perhaps, be used to cover the time involved in the two interglacial stages with the intervening glacial stage.

THE SANGAMON WEATHERED ZONE.

Earliest Recognition.—Apparently the first recognition of the occurrence of a definite soil horizon between the Iowan loess and the Illinoian till sheet is that reported by Prof. A. H. Worthen, in the Geology of Illinois (*). In his report on Sangamon county, Illinois, made in 1873, Professor Worthen called attention to a soil found at the base of the loess in Sangamon and neighboring counties. The soil apparently was first noted by Mr. Joseph Mitchell, in the excavation of wells in the northwest part of the county, and in neighboring portions of Menard county. Mr. Mitchell furnished for publication in the Geology of Illinois the following section of the beds usually penetrated:

	FEET.
Soil	1 to 2½
Yellow clay	3
Whitish jointed clay with shells	5 to 8
Black muck with fragments of wood	3 to 8
Bluish colored bowlder clay	8 to 10
Gray hardpan, very hard	2
Soft blue clay without bowlders	20 to 40

Professor Worthen states that the bed overlying the black muck is undoubtedly loess, also that the black muck indicates conditions suitable for the growth of arboreal vegetation in the interval between the deposition of the bowlder clay and the overlying loess. The name Sangamon is taken from this locality where the soil was first reported.

General prevalence of a weathered zone at the base of the Iowan Loess.—In the locality just mentioned there appears to be only a bed of muck to indicate the interval between the deposition of the bowlder clay and that of the overlying loess, for the clay immediately below the muck is described as of a blue color, a feature which suggests that there was not much oxidation and leaching or else there was subsequent deoxidation. The more common phase is a reddish-brown till surface for which Dr. H. F. Bain has proposed the Italian name "ferretto" (†)

(*) Geol of Illino's, Vol. V, 1873, pp. 306 to 319.

(†) See. Proc. Iowa Acad. of Sciences, Vol. V, 1898, p. 91.

which may or may not be accompanied by a black soil. This reddish-brown surface appears to have been developed in all places where there was fairly good drainage. But in places where the drainage was imperfect a black muck of considerable depth accumulated and the reddened zone was imperfectly or not at all developed. In western Illinois the exposures of a black soil at the base of the loess are relatively few, but the reddened till surface is a common feature in every township. In much of the white clay district of southern Illinois and in portions of the Sangamon drainage basin a black soil is well developed. A black soil is also well developed in southeastern Iowa. Where the black soil is best developed leaching is found to have extended in places only 1 to 2 feet into the underlying till, but it often extends to a depth of six feet or more. Where the black soil is absent the leaching generally extends to a depth of six feet below the base of the loess. The variations in depth of leaching appear to depend on the conditious for percolation of water, being greatest where percolation is most rapid.

Noteworthy exposures of the Sangamon soil.—A few instances of the exposures of this soil are selected which will illustrate the variability in its character. The first section, at Ashland, Ill., is near the place where Professor Worthen reported its occurrence.

The following series of drift beds was penetrated by a coal shaft at Ashland, the identifications being made by the writer from samples of the material preserved at the engine house:

	FEET.
Soil	1½
Yellow loess, fossiliferous	9
Blue loess fossiliferous	2
Peat with black sandy slush	22
Bluish gummy clay with few pebbles	20
Yellow till	30
Total drift	85

At the air shaft sand was found in the place of blue gummy clay beneath the peaty slush. A similar thick bed of peat has been noted at several other points in that region, one of the most conspicuous being in a well at Virginia City made by Mr. Oldridge. The peat was entered at the base of the loess at about fifteen feet and continued to a depth of twenty-eight

feet, beneath which a blue gummy clay was found. The drift at Virginia City has a depth of 187 feet, as shown by the coal shaft. This shaft passed through a lower black soil between till sheets at sixty-seven to seventy feet.

In the south part of the Sangamon basin, in the vicinity of Taylorville, Ill., the loess, which has a thickness of ten to fifteen feet, is underlaid by beds of sand and gravel carrying thin peat beds in their midst as well as at the junction of the loess and the sand. At the Taylorville coal shaft the uppermost peat-bed was found at thirteen to fifteen feet, and the lowest at forty to forty-four feet. Numerous exposures of this peaty material, alternating with sand beds, may be seen in ravines in that vicinity.

In October, 1896, Professor Chamberlin and the writer examined together numerous exposures of the Sangamon soil in the portion of eastern Illinois south of the limits of the Wisconsin drift, chiefly in Cumberland, Coles and Shelby counties. North of Greenup there are exposures where the subsoil beneath the Sangamon soil is traversed by branching root-like tubes one-half inch in diameter, which were easily traced ten to twelve inches below the soil proper. These tubes are filled with the black soil which apparently settled into them upon the decay of tree roots. There seems to us little question that the Sangamon soil here supported a forest. The till below this soil in these counties shows leaching to a depth of several feet. It also presents weathered cracks and seams extending down a depth of twenty feet or more. Similar leaching and weathering below the Sangamon soil has been observed by the writer in several other counties in southeastern Illinois, and in Vigo, Clay and Sullivan counties in southwestern Indiana, thus extending it to the southeast border of the Illinois lobe.

Returning to western Illinois excellent exposures of black soil and leached subsoil are found along the Santa Fe railway in eastern Knox county, of which views are here presented (see Plate iv). The soil shown in these views may be seen distinctly at a distance of nearly one-fourth mile. It is of a deep black color, resembling the surface muck found in flat portions of the uplands. The till beneath it has been leached to a depth of about four feet. The loess has a thickness of twelve feet and is slightly calcareous in the lower portion. The entire leaching of the till may confidently be referred to a date earlier than the loess deposition.

At Galva, Ill., a black soil at the base of the loess is well exposed in a clay pit at the brickyards east of the city. A large log was found imbedded in this soil which here has a depth of two feet. The overlying loess is fifteen feet in depth. A well at the brickyards penetrated forty feet of till below the buried soil, of which the upper thirty feet has a yellow color and the remainder a blue-gray color.

In southwestern Carroll county, Ill., there are extensive exposures of a soil at the base of the loess, made by the Chicago, Burlington & Northern Railway company, the loess having been removed to make a fill across the valley of Johnson creek. Probably a half acre of the buried soil is here exposed to view. It has a deep black color to a depth of ten or twelve inches, beneath which it assumes a greenish-yellow color, such as is presented by sub-soils beneath poorly drained regions. This sub-soil is leached as far down as exposed, a depth of three feet. This locality was visited last November by Professors Calvin, Udden, Bain and myself, and each recognized the clear indications of a long interval prior to the loess deposition. It may be noted in this connection that Judge James Shaw mentioned a soil in Carroll county in his report in the Geology of Illinois which apparently has the same horizon as the one just described. It was found at a depth of fifteen feet and a deposit of wood two or three feet in thickness was associated with it. (*)

On the portion of the Illinoian sheet in southeastern Iowa many excellent exposures of the Sangamon soil are found. An exposure similar to that in Carroll county, Ill., has been made at West Point, Iowa, where the Chicago, Ft. Madison & Des Moines Railway company has excavated to obtain filling for its tracks. The loess has been removed over an area several rods square, leaving the buried soil at the base of the excavation. Although the exposure is on the crest of the ridge which marks the western limits of the Illinoian drift, the soil is of a deep black color and has a depth of several inches. This exposure was visited by Professor Chamberlin, Mr. Bain and myself in August, 1896, as were also several roadside exposures between West Point and Denmark, and between Denmark and Ft. Madison.

Exposures in other portions of southeastern Iowa are given in connection with the discussion of the Yarmouth weathered zone.

(*) Geology of Illinois, Vol. V, p. 80.

Valley Excavation during the Sangamon Interglacial Stage—The large streams in western Illinois and southeastern Iowa are characterized by high, level terraces. The valleys of which these terraces are the bottoms have been formed in the Illinoian till sheet and are covered by the Iowan loess. The excavations may, therefore, be referred to the Sangamon interglacial stage. They are broad and shallow. On Skunk river, along the borders of Lee and Des Moines counties, Iowa, the terrace is only thirty to forty feet below the level of the uplands, but the valley is nearly two miles in average breadth. The valley cut below the level of the terrace is more than 100 feet in depth, but is only one-half mile in average breadth. These features indicate that during the Sangamon interglacial stage the stream had a lower gradient than at subsequent stages. On the neighboring portion of the Mississippi the valley formed at the Sangamon stage was shallow, as on Skunk river, but was not much wider than the inner valley. The large volume of water flowing through the valley at the time when it constituted an outlet for the glacial Lake Agassiz and the glacial lake in the Superior basin is perhaps the cause for the relatively great erosion subsequent to the Sangamon interglacial stage.

In southern Illinois and southwestern Indiana the main streams usually flow in broad shallow valleys, in some cases several miles in width, which were apparently built up by the glacial and fluvio-glacial deposits of Illinoian age. It is seldom that sufficient deepening of streams has occurred to produce well defined terraces; and it is not an easy matter to determine the amount of work accomplished during the Sangamon interglacial stage. On the borders of these lowlands the Iowan loess rises above the level of the modern streams, and at such places occasional exposures were found in which the junction of Iowan loess and Illinoian till is marked by a thin bed of material more pebbly than the typical till; a feature which is thought to indicate moderate stream action prior to the deposition of the loess. A similar feature has been noted on the borders of many of the small valleys in western Illinois and southeastern Iowa..

EXPLANATION OF PLATE IV.

Iowan loess and Sangamon soil exposed in a cutting on the Santa Fe railway west of Williamsfield, Knox county, Ill. Thickness of loess twelve feet. The shaded band below the loess is the Sangamon soil. It has a depth of one and one-half to two feet. The Illinoian till beneath is leached and deeply oxidized for about four feet. View taken by Frank Leverett, May, 1892. (Above.)

Iowan loess and Sangamon soil near Williamsfield, Ill., near preceding but at much closer range. View obtained by Frank Leverett, May, 1893. (Below)

Iowan loess and Sangamon soil. (Distant view above, nearer view below.)

THE WEATHERED ZONE (YARMOUTH) BETWEEN THE ILLINOIAN AND KANSAN TILL SHEETS.

BY FRANK LEVERETT, DENMARK, IOWA.

PRELIMINARY STATEMENT.

The full extent of overlap of the Illinoian upon the Kansan has not been determined. It is certain that a sheet of Kansan drift underlies the Illinoian throughout its extent in southeastern Iowa and in all probability it continues some distance eastward into western Illinois in the section between Rock Island and Quincy.

There may be a sheet of Kansan age formed by the Illinois glacial lobe. The available data, however, do not place this beyond question. Occasional wells in central Illinois are reported to have passed through a black soil at some distance below the Illinoian till. But so far as the writer is aware no exposures of such a soil have ever been discovered. Professor Salisbury has collected data in southeastern Illinois and southwestern Indiana which support the view that there may be two distinct drift sheets in that region. It is his opinion that the upper or Illinoian sheet extends farther south than the lower sheet (1). Whether the lower sheet is of Kansan age is still a matter for conjecture. It also is still an open question whether the drift on the east border of the driftless area in northwestern Illinois and southwestern Wisconsin is of Illinoian age or of earlier date. In view of these uncertainties the Yarmouth weathered zone is restricted in this discussion to the region where the Illinoian sheet of the Illinois lobe overlaps the Kansan sheet of an ice lobe lying farther west.

Numerous exposures of a soil and weathered zone have been observed at the junction of the Illinoian and the Kansan till

(1) Communciated to the writer

sheets in the region of overlap between Davenport, Iowa and Quincy, Ill. The presence of this soil horizon was first brought to the writer's notice by a well section at Yarmouth in Des Moines county, Iowa. For this reason, and because the name of this village is less likely to be confusing than names which are common, it seems appropriate to apply the name Yarmouth to this weathered zone. There is also at Yarmouth not only a soil horizon but apparently a pronounced erosion between the Illinoian and Kansan sheets.

THE YARMOUTH SECTIONS.

About ten years ago Mr. William Stelter of Yarmouth, Iowa, sunk a well near that village which passed through a bed of peat at the base of the Illinoian till sheet. The peat contained small bones which have been identified by Dr. F. W. True, of the United States National museum, as: (1) a portion of the pelvis and upper part of the femur of the wood rabbit (*Lepus sylvaticus*); and (2) the scapula of the common skunk (*Mephiticus mephitica*). The following section was furnished by Mr. Stelter soon after the well was dug, and specimens of the several classes of material penetrated were also furnished me for examination:

	FEET.
Soil and loess loam	4
Yellow till (Illinoian)	20
Gray till (Illinoian)	10
Peat bed with twigs and bones	15
Gray or ashy clay containing fragments of wood	12
Fine sand	16
Yellow sandy clay with few pebbles (Kansan)	33
Total depth	110

One mile south of Yarmouth, on the farm of Mr. F. Smith, a well was in process of excavation during a visit made by the writer to that region some years later, and the following section was determined by examination of the material in the dump, and by explanations by the well borer. The well is located on a high point of the ridge marking the border of the Illinoian drift, perhaps twenty-five feet higher than the village of Yarmouth, which also stands on the ridge. It will be observed that the black muck penetrated in this well is at a level fully forty feet lower than in the well at Mr. Stelter's. This difference in level is interpreted to be due to one well having

struck into a valley cut into the Kansan drift, while the other well entered the Kansan drift near the level of the bordering uplands:

SECTION OF WELL AT F. SMITH'S, NEAR YARMOUTH.

	FEET.
Yellow till (Illinoian)	36
Sand with thin beds of blue clay and also of cemented gravel	73
Black muck containing wood	6
Sand and gravel, probably alluvial	8
Gray silt nearly pebbleless, apparently alluvial	15
Blue till (Kansan)	42
Total depth	180

If my interpretation of the records at Yarmouth is correct there is here not only a notable accumulation of peat and muck between the Kansan and Illinoian, but also an erosion of the Kansan till sheet to a depth of forty feet prior to the deposition of the Illinoian. Since these sections are based entirely upon well records they afford a less clear idea of the relation of the beds than might be afforded by valley excavation.

EXPOSURES IN NEIGHBORING DISTRICTS.

One of the most satisfactory exposures yet found is that afforded by a ravine about one mile northeast of West Point, in Lee county. This was first seen by the writer in 1894. The following section may be obtained by descending the gully at the roadside:

	FEET.
Surface silt (loess)	6
Black soil with ashy gray subsoil	5
Brown till containing many bowlders, among which were two red jaspery conglomerates (Illinoian)	15
Black mucky soil with gray subsoil (Yarmouth)	6
Brown clay with few pebbles (Kansan)	15
Total	47

This exposure was visited by Prof. T. C. Chamberlin and Dr. H. F. Bain in August, 1896, and by each the black material beneath the till was considered a typical soil, and the gray material below a typical subsoil. The slightly pebbly brown clay beneath this subsoil shows no response with acid. Other exposures, however, have been found in which a response with

acid may be obtained within six feet below the base of the lower or Yarmouth soil.

Between West Point and Denmark, a distance of seven miles, records of thirteen wells have been obtained in which a soil was found between the Illinoian and Kansan till sheets. The thickness of the soil ranges from 2 to 5 feet and its depth below the surface ranges from 16 feet to 45 feet; the usual distance to the soil is about 30 feet. This represents, therefore, the combined thickness of the Iowan loess and Illinoian till sheet. The loess, however, has a depth of but 5 to 10 feet. Of several wells made at Denmark in 1894 to 1897 the writer has witnessed the excavation, and finds that the leaching beneath the lower soil extends about six feet into the Kansan till sheet. One of the most satisfactory sections near Denmark is the following, made on the farm of Mrs. Van Tuyl:

	FEET.
Surface silt or loess of yellow color, slightly calcareous and containing a few small pebbles near base.	7
Brownish yellow till, slightly calcareous and with few pebbles (Illinoian).	10
Brownish yellow till very pebbly and calcareous (Illinoian)	8
Blue clay with few pebbles (Illinoian).	10
Black mucky soil with wood (Yarmouth).	2
Brownish-yellow till (Kansan).	12
Hard blue till (Kansan)	6
Limestone	4
Total.	59

In this connection it may be remarked that several of the wells in the vicinity of Denmark pass through 25 or 30 feet of oxidized Kansan till and enter rock without striking a blue till, but exposures in ravines both north and south of the village show a dark blue-black till thickly set with fragments of wood. This occurs at a level lower than the rock surface at Denmark and has a striking similarity to exposures in other parts of the state, which are suspected to be pre-Kansan in age.

EXPOSURES AT DAVENPORT, IOWA.

The Illinoian till sheet as above noted is known to overlap the Kansan as far north as Davenport, Iowa. There are excellent exposures of both sheets within the limits of that city and also at points a few miles west, near Blue Grass. An exposure in Davenport, on Eighth street, between Myrtle and Vine, was

discovered by Prof. J. A. Udden, and has been visited by Professor Calvin, Dr. Bain and the writer, each of whom recognize the presence of both sheets of drift, and also the Yarmouth weathered zone. The surface of the Kansan till sheet has the appearance of slight erosion, for it shows a rise of about fifteen feet in a distance of twenty or thirty rods. The Illinoian till sheet rests uncomformably upon the eroded Kansan, reaching a lower level at the south end of the exposure than at the north. In making the descent along Eighth street the following series of beds was found:

	FEET.
Loess	30
Weathered zone of reddish-brown till (Sangamon).	3
Unleached brown till (Illinoisan)	15
Weathered zone of gummy, gray clay (Yarmouth).	3
Brown till changing to gray color at 12 to 15 feet (Kansan)	30

EXPOSURES IN ADAMS COUNTY, ILLINOIS.

The most southerly exposures of the Yarmouth weathered zone yet observed are in Adams county, Illinois. In a ravine in Woodville, in the northern part of the county, two sheets of brown till appear, which are separated by a gray, gummy clay. This clay is thoroughly leached while the till immediately above it is unleached. The latter has a thickness of only ten or twelve feet. Another exposure was found at a well in process of excavation on a farm eight miles east of Quincy. This section is similar to that in the ravine except that the Illinoian till sheet has a thickness of twenty feet. Another exposure was found north of Payson near the base of an Illinoian drift. The gray clay here rests upon a gravelly bed instead of a sheet of till, but appears to be of similar origin and age to the other beds referred to the Yarmouth stage.

Within a few miles south from this exposure the border of the Kansan drift emerges from the edge of the Illinoian, and passes southward into Missouri.

The driftless peninsula found by Professor Salisbury, here sets in and occupies a narrow strip west of the Illinois, from Pike county to the mouth of that stream,* beyond which the margins of the Illinoian and Kansan sheets take widely divergent courses. Fortunately there was sufficient overlap north from this driftless peninsula to make clear the interpretation

*See Proc. A. A. A. S., Washington meeting, 1891, pp. 251-253.

that the Illinoian is a markedly younger sheet than the Kansan. This difference in age was suspected to occur from a comparison of maturity of valleys in the two districts, but the testimony of the weathered zone preserved below the Illinoian was of value to confirm it.

THE AFTONIAN AND PRE-KANSAN DEPOSITS IN SOUTHWESTERN IOWA.

BY H. FOSTER BAIN.

INTRODUCTION.

The Aftonian deposits of southwestern Iowa have peculiar interest in that within the area is the type locality for the Aftonian. So far neither the drift of the region nor the Aftonian as a unit has received a general discussion. The references to the beds extant are merely incidental to broader studies. The type locality and several other critical exposures have been visited by many geologists but no one has presented a complete account of the beds in question. The time has not even yet arrived for an adequate discussion of the Aftonian, but in order to prevent possible misapprehensions it seems advisable to present a brief summary of present knowledge. It should be remembered that the exposures of the Aftonian and the sub-Aftonian are scattered; that their importance was unsuspected until quite recently; that in the nature of things the phenomena may be expected to be somewhat illusive, and that but little of the area has received detailed study. In view of these facts the present must be taken as a preliminary statement only and subject to considerable future revision.

Scattered evidence of a forest bed was found by White in his survey* of the region. The most noteworthy occurrence recorded by him was that of a peat bed two to three feet in thickness in Adair county.† There is some uncertainty, however, whether this peat occurs below the loess merely, or is beneath true bowlder clay, and hence, presumably of Aftonian age. A recent visit to the locality by Mr. Cowles, of the United States Geological Survey, failed to clear up the doubt on this point.‡

* Geol. Iowa, Vol. I, p. 97, 1870.
† Op Cit., p. 339.
‡ Private communication.

McGee, in his great storehouse of facts regarding the drift sheets of Iowa, mentions several points in the southern portion of the state where there are more or less clear evidences of the presence of two drift sheets. The Albia exposure, judging from the figure given,* represents the Kansan-loess contact. Presumably the Durham exposure† is to be referred to the same horizon.

The Afton-Thayer exposures were visited by McGee and Chamberlin in company, and the evidence of an interglacial interval here, in connection with the facts derived from a study of other portions of the Mississippi valley, was considered sufficient to warrant the reference of the beds to two distinct periods of glaciation. With a wise conservatism the two periods were assumed to be the same as had been demonstrated in northeastern Iowa, and accordingly in the nomenclature eventually proposed by Chamberlin,‡ the upper drift at Afton was considered to be the Iowan, and the lower the Kansan. The Aftonian beds proper were considered to represent the interval between the Kansan and the Iowan. It is important to note that in the original paper by Chamberlin the term Aftonian was not applied to the gravels which form so conspicuous a feature of the Afton-Thayer sections. These were considered to represent rather, kame-like accumulations upon the surface of the older drift sheet. This distinction has not been always clearly observed.

The Afton-Thayer outcrops are for many reasons the most important of those bearing on the question of an interglacial interval in southwestern Iowa and will be described in some detail. Preliminary to this it is desired to examine briefly what sort of evidence may properly be required to establish the presence of two drift sheets. An excellent discussion of the criteria for distinguishing between drift sheets has been given by Salisbury§. At this point it is intended merely to indicate certain of these criteria found to be of value in the Iowa work, and to discuss briefly the importance which may be legitimately attached to them.

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* Pleistocene History, N. E. Iowa, Eleventh Ann. Rep. U. S. Geol. Sur., p. 493.
† Op. Cit., p. 494, pl. lii.
‡ Great Ice Age (Geikie), pp. 773-774, 1894; Jour. Geol., Vol. III, pp. 270-277. 1895.
§ Jour. Geol., Vol. I, p. 61.

CRITERIA FOR THE DISCRIMINATION OF DIFFERENT DRIFT SHEETS.

Forest and Peat Beds.—Among the common and obvious evidences of interglacial periods none are more widely recognized than buried forests and peat beds. These constitute the one phenomenon which appeals alike to layman and geologists, and buried forests are a constant element of wonder in regions in which they are common. Their wide recognition and frequent citation has probably been out of proportion to their true importance. It is recognized alike by advocates of one and of more than one glacial period that not all forest beds may be cited as legitimate evidence of important interglacial intervals. The admitted fact that forests may and do crowd up to the edge, and even grow upon, the ice of some of our largest glaciers, makes it evident that any temporary readvance of the ice would be apt to cover up a forest bed. Whether the vegetation would follow the edge of a continental ice sheet as closely as a smaller glacier is unknown, but may fairly be considered doubtful. The real significance of a forest bed, however, arises not from the fact that it shows that during the ice period there was a retreat of the ice for a period long enough to allow vegetation to gain a foothold over areas later reburied by the ice, but from the light which they sometimes throw upon the climatic and physical conditions prevailing during the interval. If the vegetation includes plants indigenous to warm or temperate climates, it indicates a considerable climatic change, which can hardly be assumed to mean anything but a considerable time interval. The only escape from this conclusion is to assume a change in the habit of the plant in question; which would need independent proof but might be indicated by its associations.

The vegetation may, however, be of such a character as not to prohibit the assumption of a cold climate and yet its disposition be such as to indicate a relatively long and quiet period of accumulation, and, inferentially, a freedom from glacial conditions. A case in point is the Oelwein peat bed as pointed out by Professor Macbride at the last meeting of the academy.* The evidence in such a case is obviously, while still important, of less value than in the former.

It is conceived that if a forest bed, even if it showed only a boreal or possibly boreal vegetation, could be proven to occupy

*Proc. Iowa Acad. Sci., Vol. IV, pp. 63-68.

the same or approximately the same horizon over a wide stretch of country, the legitimate inference would be an extensive retreat and readvance of the ice. In the nature of things, however, it is impossible often, if ever, to apply this test alone, and in general forest beds, except where they show tropical or temperate floras, have little independent value.

Buried Soils.—This term is intended here to cover only the black soil proper; the clay mixed with humus. Under ordinary circumstances this is not deep, and in general over the Wisconsin drift it is about 8 to 12 inches in thickness. Since the soil comes from the successive growth and decay of vegetable matter, and since but a small fraction of the latter is usually preserved, a soil calls into consideration an important time factor. It is true there are instances of rapidly formed soils but such may in most cases be discriminated. The peat represents the forms of relatively rapid vegetal accumulations and six inches of true soil means a much longer time period than the same thickness of peat. It is important, however, to carefully discriminate true soils from apparent soils found by the washing in of soil material. At Fort Dodge the Des Moines valley is apparently post-Wisconsin; yet, in some drift exposed down in the valley, is a soil as deep, and as well marked as that over the upland drift. The explanation seems to be, not that the lower drift is older and separated from the Wisconsin by an interval as long as post-Wisconsin time, but that the exposure represents a buried terrace, and that the soil was not altogether developed *in situ.* When, however, the soil is clearly developed *in situ*, it has a considerable significance. In such cases it will, with certain rare exceptions, be accompanied by concordant phenomena and occasionally the latter afford the only means by which its genuineness may be proven.

Leached Horizons.—That the drift contains a large amount of mechanically pulverized material has been abundantly shown. In Iowa one of the most abundant materials is pulverized limestone, and it is pertinent to remark that this material is quite abundant even in the material covering the Des Moines formation, our most important series of beds relatively free from limestone. One of the first processes becoming active in the formation of a soil is that of leaching. The soluble materials begin at once to go into solution and drain out of the upper portion of the soil. As a result acid finds little to dissolve in old soils and much in new drift soils. In the process of time

the leaching progresses farther and farther down from the surface, so that the width of the leached zone comes to be an index to the age of the soil. It is obvious that the amount of leaching is really proportional, not directly to the time, but to the amount and strength of solution draining through the soil. An exposed point may be subjected to a greater amount of solution running through it. Conceivably also, the strength of the solution might vary from point to point and from time to time. A leached zone, then, to have value in this connection must be shown to be general, and these local factors must be eliminated. A widespread and well marked zone with the strength of the acid reaction uniformly proportional to the distance below the presumed horizon can, however, hardly be explained, except as a true index of time. It is believed also, that at least in an approximate degree, the amount of leaching shown by two surfaces gives a reliable means for comparing their ages. It may be noted in passing that to get accurate results hot acid should of course be used in testing till derived from dolomitic regions.

Ferretto Horizons.—To those who live in the southern portion of the state where the Kansan drift is exposed beneath the loess, no phenomenon is more common than the reddish-brown horizon marking the upper limit of the drift. This old, red soil, for such it is, is of the type known to the Italian geologist as ferretto, and the name seems fitting and is useful. The ferretto zone is manifestly due to the high state of oxidation of the iron. The red-brown color shades off through orange and yellow into the blue of the lower portion of the till, the change being gradual, and the yellow clay being usually ten to thirty feet thick.

The reddish zone is narrower, and while its lower limit is naturally but poorly defined, the ferreto zone proper is usually but two to three feet in thickness. The progressive increase in the oxidation of the iron toward the surface is accompanied by a similar increase in general oxidation, and increasing rottenness of the bowlders and pebbles. There are exceptions and fresh bowlders occur well to the top, and even on the surface of the drift, while rotted cobbles are found to the bottom. Such, however, is not the rule. In the formation of ferretto and in the broader work of general oxidation and decay of pebbles local causes favoring or hindering the action come into play, and it is the relations of the phenomena to an old general surface that cause its significance. The local variations are

usually easily discriminated, and in practical field work only occasionally lead to confusion.

Waterlaid Beds.—In general geologic work the record of the past is read in the deposits of the succeeding periods In a large majority of cases these deposits are waterlaid, and each class of waterlaid beds, river, lake and beach, have distinctive characteristics. If, then, waterlaid deposits be found buried in the drift they may show, either by their physical character and distribution, or by their contained fossils, something of the length and prevailing climate of the period in which they were laid down. Unfortunately, perhaps, there is always a considerable amount of water action in connection with an ice sheet and large bodies of waterlaid beds, contemporaneous with one stage of the ice, may be buried beneath the drift after a wholly unimportant interval.

The gravel beds may, and do, grade laterally into the drift, proving their contemporanity. They may also carry large numbers of flattened and striated stones, obviously not long subjected to the wearing action of running water. On the other hand they may be well rounded and water worn and indicate deposition at a considerable distance, at least, from the ice front. The gravels, whatever their form and origin, may be fresh, hard and uncemented, or they may be weathered, soft, ferruginated and cemented into conglomerate. Since gravel beds are readily permeable and afford easy channels for underground water it may be granted that all the processes indicated might leave their marks upon a really young gravel. As a matter of fact, however, the gravels found in connection with the Wisconsin drift are almost uniformly fresh, while the Buchanan gravels, and the few which have been referred to the Aftonian quite as uniformly show signs of age. It would seem that this possible source of error is really after all quite unimportant. Furthermore, it has often been shown that in many cases the weathering of the bowlders, both in the gravel and in the older tills, took place after they were glaciated.

Topographic Changes.—One of the most easily recognized and significant phenomena indicative of differing ages is topographic change. It is true that the rate of development of topography is dependent on several variable factors, and may differ both in relation to position and time, but the elements due to these factors may often be eliminated, and in such cases the topographic differences become probably the best indices

of the time relations. In considering drift sheets which are deployed, the topographic element is of great importance. The pre-Kansan drift is, however, so far as is now known, unexposed except where the Kansan drift has been cut through. The topography of its surface is accordingly almost wholly unknown. The little which we do know, however, is especially significant.

Physical Character of Till.—When in studying the indurated rocks one finds above a widespread and characteristic sandstone, a limestone, a dolomite, or even a sandstone of different character, he suspects at once that he has to deal with a different formation. To a certain extent the same sort of criteria may be applied in a study of the drift. It has long been recognized that marked differences in the character of the bowlders carried betokens differences in the genesis of the drift. Originally this was interpreted as meaning a change in the direction of the ice currents. Recently this has been synthesized and now the phenomena are used to discriminate centers of dispersion. Aside, however, from the differences in the bowlders, there are certain differences in the physical aspect of the drift itself which come to mean much to the field worker. Such differences are hard to put into words, and it is not always possible to analyze them and so detect the underlying cause. They cannot always be detected and there are many things which may be deceptive; yet the character of the drift is often very helpful. For example, the yellow clay of the Iowan drift is usually more friable than that of the Kansan. The well known "feel" of the loess is another case in point. As a rule the blue clay of the Kansan has the character of a joint clay, breaking with little cubical blocks on drying, etc.

Cumulative Value of Evidence.—It is a well recognized fact that many isolated bits of evidence have a cumulative value. A fact which standing alone would fail to do more than excite a languid curiosity, when ranged side by side with many similar facts, takes on a deeper significance; while a study of the assemblage of independent evidences will often convince the veriest skeptic. Out of small and individually weak brick, a large and trustworthy wall may be erected. So in the study of the drift sheets. As has been suggested, one class of evidence is rarely found alone; but the whole often unite to make clear a record which could not be deciphered from any one. Even the most intangible of all, the physical aspect of the drift, is often the one first observed, and it serves in no small number

of cases to give the primary suggestion of the solution of the difficulty, leading one to seek for and find other and surer evidence.

THE AFTON-THAYER EXPOSURES.

The Aftonian beds are not positively known to occur in or immediately adjacent to the city of Afton; the latter is, however, the best known town near the original exposures. The beds are seen well exposed at three abandoned gravel pits located three to six miles east of Afton proper. These are (1) between Afton Junction and Talmage; (2) about one mile southeast of the Junction on the south side of Grand river; (3) about three-quarters of a mile west of Thayer on the south side of the Chicago, Burlington & Quincy railway. For convenience these will be called the Afton Junction, Grand River, and Thayer pits, respectively. The Afton Junction pit shows the overlying loess, the Kansan drift and the gravels with certain buried silts or loess beds below the latter. The Grand River exposure shows the upper and lower drifts with the gravels between. The Thayer exposure shows the gravels and the overlying drift with certain sands and fine clays between.

Afton Junction.—The pits at this place are about 1,500 feet north of the railway station, on the west side of the Chicago Great Western. They have been opened along the sides of a small stream running east and emptying into Grand river. The north side of the pit is bilobate, the minor lobe being to the east and not directly in line with the main face of the pit. The two lobes in fact form an arc of a rude circle rather than a straight face. Between the two lobes is a small ravine which has cut down to, but not through, the gravels. The main face (Plate v) is about 1,000 feet long and has a maximum height of probably seventy feet. The minor or east lobe is about 400 feet long and fifty feet high. The bottom of the pit, said to rest on "quicksand," is cut down to about the level of Grand river bottoms (1030 A. T.). The stream is here of post-Kansan age. The section exposed at the main face is as follows:

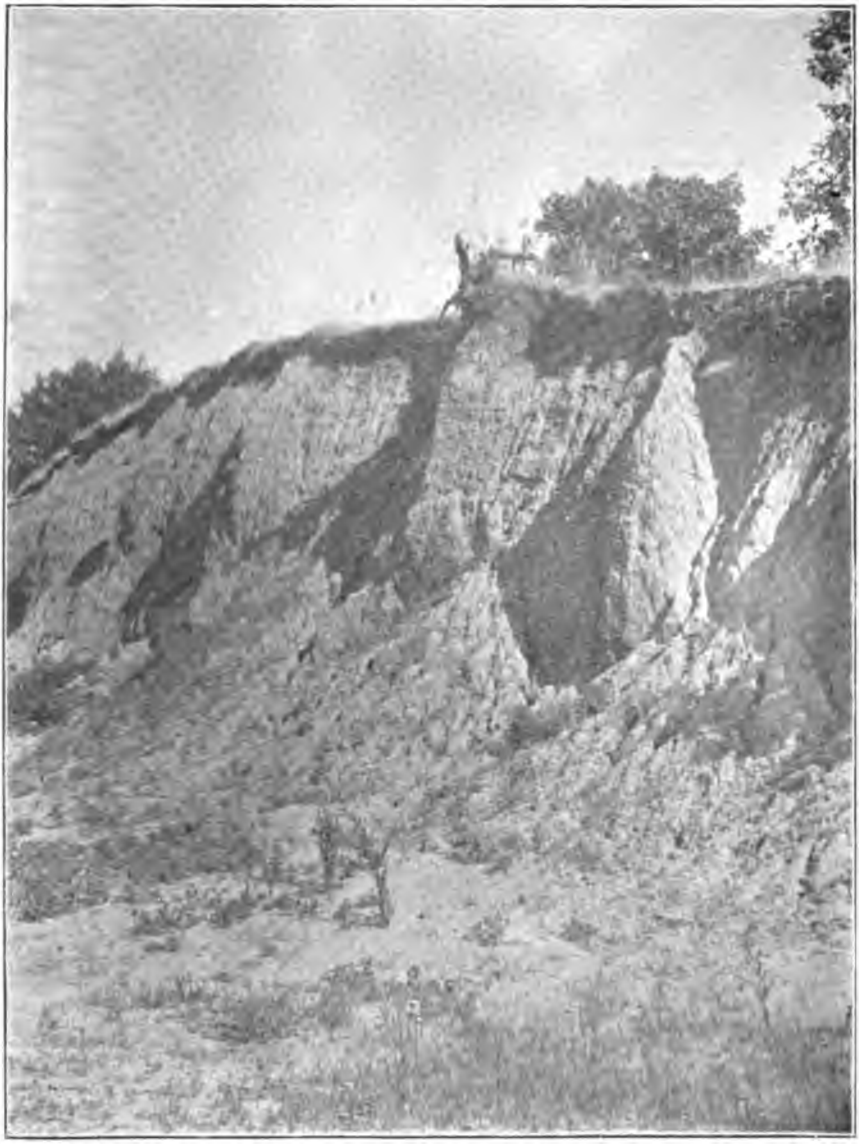
	FEET.
Loess of the usual upland or older type, characteristic of the region	10
Yellow bowlder clay with upper portion much oxidized, leached and highly colored; lower portion running into a blue with weathered joint cracks, containing much weathered material and planed and striated bowlders, characteristic Kansan	30

	FEET
Gravel, coarse, cross-bedded, iron-stained, cemented in part into hard conglomerate; made up to considerable extent of very badly weathered material, manifestly an old gravel	40

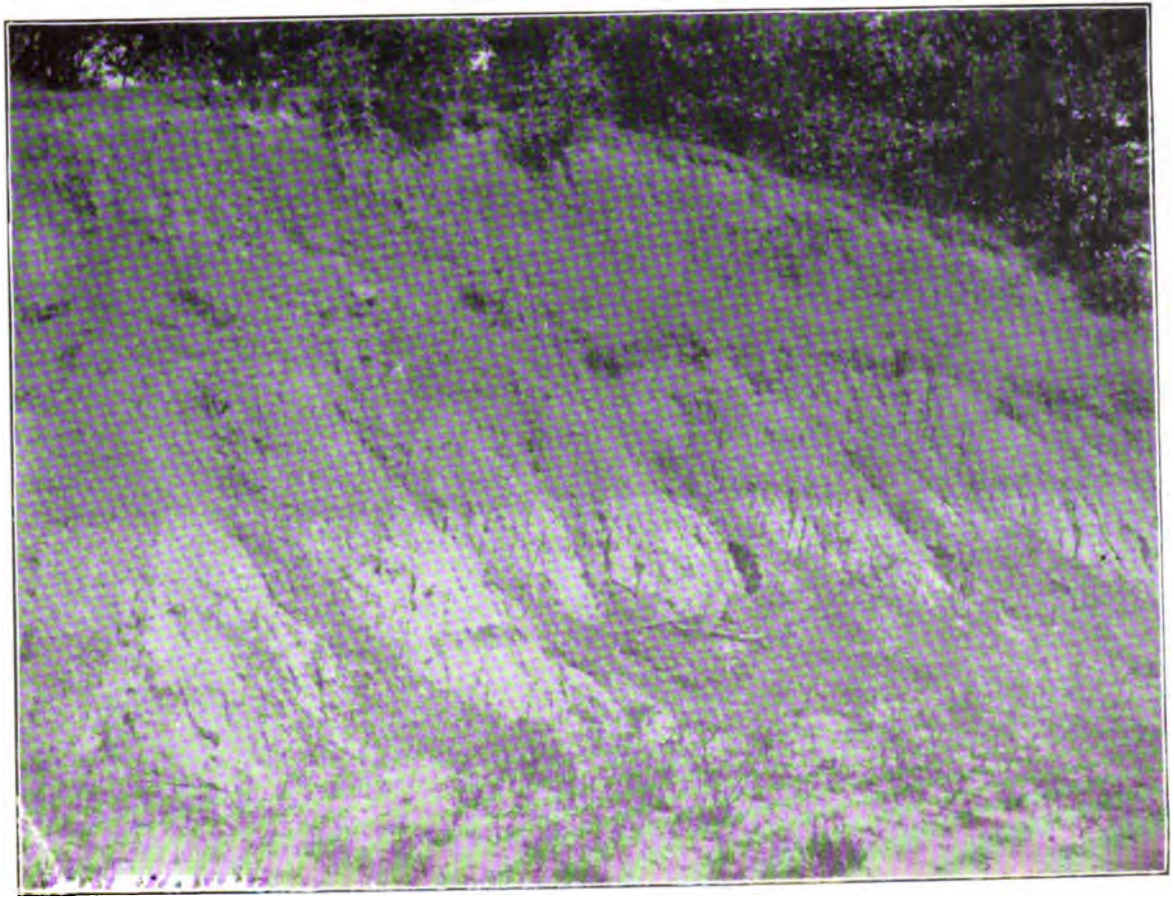
Down to the gravels this is the normal section for the region and could be duplicated at hundreds of points. The ferretto zone is well developed and its coloring is dark enough to show excellently in a photograph. The drift and loess are identical in every particular with that found throughout southern Iowa and there can be no doubt whatever that the drift is Kansan.

The drift shown in the east lobe is of the same character as that overlying the gravels in the main face, and the identity of the two has not been questioned as far as is known to the writer by any who have visited the place. Among the latter may be mentioned Professors T. C. Chamberlain, Albrecht Penk, Samuel Calvin and S. W. Beyer. Prof. G. F. Wright has seen the exposure but his opinion on this point is not known to the writer. The drift in the east lobe lies at a considerably lower level than in the main face, extending in fact down to the bottom of the pit. As the railway near the station just cuts into the top of the gravels a few feet, this was, when first seen, interpreted to mean that the gravels formed a kame-like ridge with a northwest-southeast trend and that the drift had been laid down over this ridge running down over its side. It was thought likely that there had been some erosion whereby an eastern extension of the gravels had been cut away before the drift of the east lobe was laid down, and that, accordingly, the position of the drift indicated, or at least accorded with, a certain time interval between the gravel and the overlying drift. Recent studies fail to sustain this view. The Great Western Railway company undertook to open up the gravels at the point near the station where they showed above the track. As the steam shovel traveled to the north it was found that the gravel contained more and more clay until ordinary bowlder clay was being handled, and the work was stopped. An examination of the east lobe of the old pit apparently indicates that the same transition occurs there. In the photograph (Plate vi) faint lines of stratification will be noticed running through the bowlder clay. So faint are these in that portion some distance from the gravels that they were at first entirely overlooked. Re-examination showed, however, that the bowlder clay is

General view of the Afton Junction gravel pit, showing the gravel exposed in the face of the main lobe and covered by the Kansan and loess.



East lobe of the Afton Junction gravel pit showing lines of stratification in the drift.



Old loess-like material below drift, presumably Kansan, at the extreme end of the Afton Junction gravel pit.

really stratified, the lines of stratification becoming more distinct as one passes towards the gravel and stringers of the latter becoming more frequent in the bowlder clay. The relationship has been somewhat obscured by the circumstances of a stream pouring down at the contact of the two lobes, but it seems quite clear that the east lobe is composed of stratified material which is intimately connected with the gravels. In the opposite direction the signs of stratification become more and more obscure until the drift can not be told from the ordinary yellow clay of the Kansan. The transition is not, however, so open to observation and there is a possibility that the stratified drift is distinct from the yellow clay of the region, though there is no known evidence proving it so.

At the extreme east end of the east lobe there is exposure showing the beds below the drift. This exposure is in a borrow pit made in getting material for the railway fill and is represented in the third photograph (Plate vii.) The overlying bed here is the yellow clay of the Kansan. It is the continuation to the east of that shown in the former photos. It is here so far from the gravels that it shows no signs of stratification nor indeed anything to indicate that it is anything more than the ordinary yellow clay of the Kansan. Beneath the bowlder clay will be noted a pebbleless clay resembling the loess. Indeed one might imagine it to be the ordinary drift-loess section of the region reversed and minus the ferretto zone. In fact that is exactly what it is, a loess buried beneath yellow bowlder clay. In all important respects it so closely resembles the ordinary upland loess that the two could probably be discriminated only with difficulty. The loess shows under the stratified bed of the east lobe, though it carries here some very fine gravel and is more of a silt than a loess.

Grand River Section.—The exposure on the river proper is about one mile away though one exposure is in view from the other. Between, ordinary erosion has cut away the connecting beds; but looking across the amphitheater the connection is obvious. This section is the only one in the region showing the lower till and is accordingly of exceptional interest. The full exposure shows the loess, Kansan drift and gravels as seen elsewhere. Beneath them are the following beds:

	Feet.
Bowlder clay (sub-Aftonian), a blue-black clay not weathered at top and coming into sharp contact with the ferruginated gravels, containing mainly small pebbles, predominantly of vein quartz, but with a fair proportion of granite. Many, if not most, of the pebbles fresh and hard	40
Red and blue shales of Missourian.................	20

The peculiar physical character of the lower bowlder clay is striking. It is dense and breaks usually in flakes rather than joint blocks. It is of a strikingly dark color. There are few joint cracks and these show no special signs of weathering. The sharpness of the contact between the gravels and the bowlder clay, with the presence of many hard pebbles in the latter, indicates apparently one of two things, (1) either this lower clay was not exposed to surface action before the gravels were laid down, or (2) it was so vigorously eroded immediately before the deposition of the gravels as to cut away all evidence of former surface exposure.

Thayer Section.—The Thayer section is of interest, since it seems that here the evidence of two drifts was detected. The section as now shown varies a little from point to point in the pit but a representative exposure shows the following beds:

		Feet.	Inches.
9.	Black soil............................		6
8.	Reddish gravelly clay (ferretto).......	1	
7.	Yellow bowlder clay becoming gravelly below and containing quartzite, greenstones and granite; flattened and striated pebbles with lime concretions......................10 to	20	
6.	Fine sand	1	6
5.	Drab to blue pebbly clay with sticks and bits of undetermined wood.....	4	
4.	Fine sand............................	3	
3.	Drab pebbly clay as above............	12	
2.	Fine sand............................	2	
1.	Gravel as seen before, striated and cross-bedded; pebbles mainly less than 1¼ inch in diameter but with some large bowlders. Material seemingly of the usual Kansan facies, much weathered and highly colored.........................15 to	20	

Summarizing the above, we have loess and yellow and blue clay phases of the Kansan with the underlying gravels. The

blue clay phase of the Kansan is unusual in the presence of interstratified beds of fine sand and in the abundance of woody material. It is dark and might readily be taken for a buried soil, though there is some doubt whether this is the true interpretation. The portion of the pit examined by McGee and Chamberlin is not now open to examination. It seems to have then presented much better evidence of a soil above the gravel than can now be found. The material seen is stated to have given a clear impression that it was a mucky soil accumulated on the lee slope of the gravel hill. It contained much vegetal material, and while normally but three to four feet thick, was at one place bunched up to a thickness of six or eight feet. The material now found at that horizon some few feet farther east is full of pebbles and, except for the darker color and woody material, does not differ from blue bowlder clay.

The question raised by the various Afton exposures are numerous. The principal ones are (1), are there two distinct drift sheets present? and (2), if two drift sheets be present is the unconformity above or below the gravel beds? The earlier interpretation was that two drift sheets were present, that the gravels represented kames connected with the retreat of the earlier ice, and that the blue-black clay at the base of the Kansan as seen at Thayer was in part, at least, a soil, and marked the Aftonian horizon proper. An alternative hypothesis would consider the evidence of two drifts, so far only as these particular exposures are concerned, as perhaps not wholly unassailable, and would place the dividing line below the gravels. In support of the latter hypothesis, it may be urged that so far as the exposures now show there is nothing comparable to a soil above the gravels except at Thayer, and that even here the beds may be explained, though perhaps with some difficulty, as merely a portion of the blue clay phase of the Kansan. The passing of the gravels by lateral transition at three points into bowlder clay undistinguishable from, and apparently connected with, the overlying Kansan, would seem to argue a contemporaneity of age. It is possible, however, that the effect of a later ice sheet working against the edge of a loose gravel hill would be to obscure the distinctness of the two deposits more than has been thought. Perhaps the loess-like clay seen beneath the stratified beds and proven by test pits to run beneath some, at least, of the gravel, may be urged as evidence of an unconformity below the gravel. As it is quite probable that the gravel pits

will soon be extensively reworked and final evidence upon some of these questions will then be at hand, no attempt will be made for the present to determine the balance of probabilities between the two hypotheses.

CO-ORDINATE PHENOMENA.

Before taking up the question of the presence of two drifts in the larger region it will be advisable to mention certain additional exposures. In the immediate vicinity of Afton a buried peat bed has been reported from several wells, and specimens of peat collected by Mr. William Haven, leave no doubt as to its nature. This bed is found at a depth of about forty feet in situations which seem to indicate that it is lower than the base of the loess.

Following down Grand river traces of the gravels are occasionally seen and at Reynolds ford, near where Union and Decatur counties corner, the beds are exposed with a thickness of 15 feet. They rest as at the exposure already described upon a blue-black bowlder clay of peculiar physical character and unlike the usual blue clay of the Kansan. In the southern portion of Decatur county below Davis City (southwest of northwest section 18, Hamilton township) is another exposure of bowlder clay of this character and over it are some beds of stratified material. Between the two points south of a small country town called Terre Haute (section 28, Burrell township) is an exposure in the south bank of the river showing a soil below yellow bowlder clay answering to the Kansan and having here stratified material below. This exposure is not altogether satisfactory and has been discussed elsewhere* but should be kept in mind in offering an interpretation for the region.

In the southwestern portion of the county a forest bed has been reported from several wells. Mr. Fitzpatrick has noted it at Lamoni at a depth of 85 feet with 100 feet of bowlder clay below. In Harrison the adjoining county in Missouri, Dr. Keyes informs the writer that a peat bed as much as nine feet thick has been found at considerable depths. Near Osceola and again near Leon there is a buried gumbo which, while it is believed to represent merely an episode in Kansan history is possibly susceptible to another interpretation.† Near Sigourney, in Keokuk county, Mr. Leverett has noted an old soil in the drift far outside the limits of both the Iowan and the Illinoian.

*Geol. Decatur Co., Iowa Geol. Sur., Vol. VII. In press.
†Geol. Decatur County.

The forest bed at Washington has often been referred to. Buried forests have been reported in the region at Murray, Fontanelle, and points in Taylor county and, while the phenomena have not yet been carefully collected and studied, enough is known to prove that the facts are not isolated; and some of them, at least, seem worthy to serve as a basis for generalizations.

The exposure near Hastie, first described in a meeting of this Academy* and more fully described in the reports of the Geological Survey†, is probably to be considered in this connection. In view of the results of the past season's work in the discovery of correlative evidence it now seems that the argument from erosion then suggested is a good one and that there is an important time break between the gravels and the Kansan drift. Certainly a time break which was sufficient to allow the Des Moines to clear out of its old valley forty feet of drift so completely that only a few scattered remnants are left, is not to be considered trivial.

SUMMARY.

In considering the conclusion to be drawn from the evidence now in hand the remarks relative to the value of the various lines of evidence should be kept in mind.

First.—It is submitted that there is widespread evidence of buried forest and peat beds in the region. It is admitted that nothing of importance bearing on the character of this flora as regards climate is known. It is further admitted that these notes on forest beds have not been sifted, and much of the evidence is of uncertain value. It is, on the other hand, to be noted that certain of the beds are well attested as to position, occupying a horizon fitting well with the hypothesis of two drifts, and that some are of a thickness worthy of consideration. Upon the whole, however, the argument from forest beds alone probably has but slight value.

Second.—Buried soils have been shown to be not unknown, though the value of the evidence derived from them is uncertain.

Third.—It has been impossible so far to apply the ordinary tests based on leached and ferretto zones to the sub-Aftonian.

Fourth.—Waterlaid beds are present at several points at the Aftonian horizon. In Polk county they are believed to be

* Keyes and Call, Proc. Iowa Acad. Sur., 1890-91, p. 30.

† Vol. VII, Geology of Polk County, pp. 336-338, 1897.

notably earlier than the overlying drift. At Afton they seem to represent kame-like aggregations, but whether made during the advance of the Kansan, or the retreat of the pre-Kansan, is not entirely certain. In general the waterlaid beds are such as might have been formed by agencies closely connected with the ice. The possible exception is the buried loess at Afton Junction, which, however, would only necessitate a considerable change in the vigor of deposition between the time of its formation and the laying down of the overlying gravel.

Fifth.—Since the presumed sub-Aftonian drift is thought to be wholly covered by the Kansan, and is certainly known to be in the region studied, there is but little chance to contrast the topographic development of the two drift surfaces. Relative to erosion in the period between the two drift sheets it may be stated that the Hastie exposure strongly favors such a supposition. The evidence pro and con at Afton exposures is in too uncertain a condition to warrant any conclusions. It may be said, however, that there is much which indicates a notable period of erosion and very little, if any, evidence against it.

Sixth.—It has been shown that there are exposures in the region of a drift of peculiar physical type That this drift is wholly unlike any known phase of the Kansan, and that in every instance there are some independent phenomena favoring the hypothesis that it is distinctly older than the Kansan. Whatever one may think of correlations based upon physical characters these facts are certainly of some significance. Furthermore the same facts are true of the known exposures of the presumed pre-Kansan drift at Muscatine, Oelwein, Albion, and indeed throughout the state.

General Conclusion.—It is believed that the argument for a pre-Kansan drift sheet derived from erosion is strong, and that it has independent value. The arguments from other sources tend to greatly strengthen it, and the cumulative force of the whole is believed to be sufficient to put the burden of proof upon those, if any, who would attempt to deny the existence of a pre-Kansan drift. All would, however, probably agree to the statement which the writer believes warranted by the evidence in hand, and which he expects future investigations to amply confirm, but for anything beyond which there is probably as yet no sufficient evidence: that there are in Iowa traces of a drift sheet older than the Kansan and separated from it by an unknown, but probably considerable, interval.

It may be mentioned in conclusion that it has been suggested, notably by Chamberlin,* that a complete series of deposits recording a glacial period should theoretically include a series of early deposits made by minor advances of the ice of increasing intensity, covered by those of the maximum advance which in turn should be covered by a second series of deposits made by minor advances of decreasing extent. So far only the maximum and some of the later drift sheets have been discriminated. It is believed that the pre-Kansan drift probably represents one of these earlier and minor extensions of the ice sheet.

It is to be noted that the Aftonian as first used was correlated with the "forest bed" of McGee. Recent work has shown that in northeastern Iowa two separate horizons were confused under the latter title. Inasmuch as at some points the "forest bed" is now believed to be between the Kansan and pre-Kansan, rather than what is now known as the Iowan and Kansan, the original determination was in so far correct, and these would accordingly be legitimate reasons for applying to the upper drift of southern Iowa the term Iowan. The final usage will be to some extent determined by the fact as to whether or not the pre-Kansan or the Kansan of present usage, is really the surface drift of eastern Kansan.

The recent changes are in the matter of dividing the formation which McGee called his "upper till." Since the peculiar topographic forms which he so well described, and which are so generally associated in mind with his "upper till" belong to that portion of it now recognized as Iowan, and furthermore, since northeastern Iowa has been considered the type region for the Iowan, present usage will probably prevail, but this possible change should not be lost sight of.

In studies in the Alpine glaciation of Europe three periods of glaciation have been made out. These include, (1) a fresh, young till, (2) an older widespread till, and (3) a very old and imperfectly known till.† In a general way the Iowa section may be correlated with these beds. No. 1 answering to our young drift, Iowan or Wisconsin, or both; No. 2, the Kansan; No. 3, the pre-Kansan.

The Illinoian seems to have no correlative in the Alpine section, unless possibly this middle drift should prove capable of division. Until, however, much more is known of the pre-Kansan such correlations must rest on rather slender data.

*Great Ice Age (Geikie), p. 736. 1895.

†Le Systeme glaciare des Alpes, Penck, Bruckner et du Fanquier.

SOME PREGLACIAL SOILS.

BY J. A. UDDEN.

In the region south of the Wisconsin Driftless area an old soil is occasionally found under the Kansan drift, generally resting on the bed rock, and often associated with laminated water-bedded clay and other silt. It is exposed under a bluff of drift in the southern part of Muscatine, Iowa. The material is here dark brown in color, mottled with small black fragments of vegetable tissue. The upper part is a dark mucky clay. The whole bed is only two or three inches in thickness. It lies below what appears to be pre-Kansan drift. At Davenport, Iowa, a similar bed was uncovered in the grading of the river bluff on the east side of Eastern avenue. At this place it had a somewhat darker appearance, owing possibly to the fact that it had been less subject to recent leaching in the exposure made. At Rock Island, Ill., the same soil bed has been encountered in several wells which have been dug near the river bluff. One of these wells is near the crossing of Thirty-fifth street and Seventh avenue. The section penetrated by this well consisted of loess, apparently two sheets of till, silt, varying from a black muck to a grayish loess with small gasteropods, and then a greenish sticky clay containing fragments of the local bed-rock but apparently no archaean pebbles or bowlders. This latter clay was some five feet in thickness and rested on the soft shales, or clays, of the coal measures. It seemed to be a residual material of preglacial age, lying undisturbed on a slope of the bed-rock. The silt and muck above it contained fragments of wood, one of which measured nearly two feet in length and several inches across. Silt of the same kind and in the same position, but oxidized and without fragments of wood, has been exposed in the grading of some of the streets near by. On Thirty-ninth street it contained the following fossils:

Helicina occulta Say (common).
Pupa alticola Ingersoll.
Pyramidula striatella Anthony.
Succinea avara Say.

Similar deposits, though without fossils, occur under the drift in the bluffs east of Cordova in Illinois, and in the northern part of the city of Clinton in Iowa. At the latter place they are finely laminated and are associated with a peaty or soil-like layer. A deposit which appears identical with the loess-like silt on Thirty-fifth street in Rock Island is found underlying the till on the east line of section 12, T. 17 N., and R. 1 W. south of the city, and also in a gully near the bluffs of the Mississippi river in the west end of the county on section 31, T. 16 N., R. 5 W. At the former place it rests on the coal measures and contains in about the same relative abundance the same fossils that were found in the silt exposed on Thirty-ninth street in the city. In the exposure in the west end of the county the underlying beds are not seen. The total thickness of the drift above it is about 100 feet. Shells are abundant and they are of the same kinds and of the same relative frequency as at the former place. The following species have been identified by Dr. W. H. Dall of the U. S. National museum:

Helicina occulta Say (abundant).
Helicodiscus lineatus Say.
Limnæa humils Say.
Pupa armifera Say.
Pyramidula perspectiva Say.
Pyramidula striatella Anthony.
Strobitops labyrinthica Say.
Succinea avara Say.
Succinea luteola Gould.
Polygyra, sp.
Vitraea arborea Say.

These loess-like deposits have a bluish-green color in fresh exposures, but one season of weathering gives them a reddish-gray hue to the depth of one or two feet and then their resemblance to the loess in color, as well as in structure, is quite marked. Even the tubular ferruginous concretions of the latter deposit appear.

The precise relation of the soil beds to this deposit and to the laminated silts, with which it seems to be associated, and

the relation that the two latter have to each other can not be fully made out from the known exposures. In the well on Thirty-fifth street in Rock Island there seemed indeed to be two soil horizons. The section under the Kansan till was as follows, beginning above:

	FEET.
Black sticky muck with large fragments of wood..	4
Loess-like, ash-colored material with pulmonate fossils	8
Black muck	4
Residual clay full of local rock fragments	5
Coal measures	

All the fragments of wood found in the ancient soils belong to gymnosperms, and this may be regarded as indicating a boreal climate, such as would precede the advance of the ice. The position of the deposits under the till indicate that they are pre-Kansan in age, and possibly preglacial. The region in which they occur lies to the south of the Driftless area, where the abrasive work of the ice seems to have been small in amount. Erosion contours of two and three hundred feet in elevation lie buried under the drift in this region, and glacial scorings are unknown. Among such surroundings it would be more singular that preglacial surface deposits should be wholly absent than that they should occasionally come into view.

THE DRIFT SECTION AND THE GLACIAL STRIÆ IN THE VICINITY OF LAMONI, IOWA.

BY T. J. FITZPATRICK.

Workmen digging a well at the elevator during April, 1896, came to a forest bed at a depth of eighty-five feet below the surface. Quite a number of pieces of wood were removed, one being a branched log, eight inches in diameter and five or six feet in length. Three pieces were secured by the writer and microscopic sections made of the wood revealed the border pits, characteristic of conifers. The materials passed through above the forest bed were composed of yellowish and blue clay charged with usually small pebbles. A 425-foot well drilled by the city, two blocks north of the elevator, has left only an obscure record. The only data of interest preserved were the facts that the limerock was 200 feet below the surface, and the materials passed through above were clay and gravel.

In several other deep wells dug in the immediate vicinity driftwood has been found at the same horizon as in the elevator well, and in all cases drift material has been found below the forest bed.

S. B. Hartshorn, living five and a half miles southwest of Lamoni, has a well 221 feet deep. He gives the following section beginning at the surface:

DEPTH BELOW SURFACE—FEET.	THICKNESS OF MATERIAL—FEET	REMARKS.
88	88	Clay and gravel, at the bottom of which drift wood was found.
90	2	Sand.
169	79	Blue clay.
199	30	Sand, at the bottom of which driftwood was found.
200	1	Sand rock.
221	21	Blue and whitish clay.

The section in several particulars wants authentification. The driftwood at the depth of eighty-eight feet corresponds

to the driftwood horizon of the elevator well. But there appears also a driftwood bed at 199 feet below the surface, to which the writer cannot as yet give credence. The drift section is also thicker here than at Lamoni, as the bottom was not reached at 221 feet, whereas at Lamoni the country rock was reached at 200 feet.

A small tributary of Grand river, known locally as Potter's creek, running east through Burrell township, passes from its source rapidly down through the drift and reaches the upper surface of the Carboniferous rock, near the eastern part of section 30, Twp. 68 N., R. 26 W., Burrell township, in the immediate vicinity of Krucker's quarry. At this point the creek makes a sharp angle and rock is exposed for a distance of 100 feet near the water edge. The entire surface exposed is glaciated. The striæ in general are S. 1° W., varying to as much as S. 4° or 5° W. A few are S. 5° E., or even greater. All these bearings are with reference to the magnetic meridian. The accompanying plate (Plate viii) well illustrates their character. The bluff rises abruptly from the glaciated rock to a height of forty-five feet. The lower six feet as exposed is blue clay; the upper thirty-nine feet is yellowish clay filled with pebbles and lime. The hill slopes back from the summit of the bluff in a short distance to a height of 110 feet above the striæ, while the distance passed down from the well at Lamoni to the glaciated rock is 245 feet.

The drift from the surface to the forest bed, eighty-five feet in depth, is referred to the Kansan stage. The buried forest bed is an interglacial stage now referred to the Aftonian. During this stage the climate was mild and coniferous forests were in all probability abundant, but went down before the irresistible advance of the Kansan glaciers, and became covered with a heavy mantle of drift debris. The drift material below the forest bed is at present referred to the pre-Kansan or Albertan stage. Should the finding of a second horizon of driftwood, as indicated by S. B. Hartshorn's well, be confirmed this stage may be divided. Further developments will be awaited with interest. The glacial striæ on bed rock may be referred to the advance of the glaciers as they bore southward. The striæ were subsequently covered by glacial debris to be exposed by erosion since the final invasion.

GLACIAL STRIAE AT LAMONI

PLATE VIII.

NOTES ON THE FLORA OF NORTHEASTERN IOWA.

BY T. J. FITZPATRICK.

The following notes are the result of a series of studies made during the summer of 1895 when the writer passed down the Upper Iowa river from Decorah to its mouth and thence down the Mississippi river to Muscatine, examining enroute the floras of Winneshiek, Allamakee, Clayton, Dubuque, Jackson, Clinton and Scott counties. Much field work was done by collecting specimens and taking notes. The writer received aid subsequently in the examination of a collection from Winneshiek county made by Herbert Goddard of Decorah, Iowa. All the rare or infrequent species mentioned in the following list are represented in my herbarium. Those common as *Quercus alba*, *Ulmus americana*, *Populus monilifera*, *Xanthium canadense*, etc., are not represented by specimens from all the localities given

The difficult species have been carefully compared with specimens in the herbarium of the State University of Iowa, or submitted to competent botanists. The sedges were determined by R. I. Cratty, the grasses by F. Lamson-Scribner, and miscellaneous species by the officers of the Missouri Botanical Garden at St. Louis. The writer hopes the following notes may be beneficial to students who study the flora of that portion of the state, a flora unique in many respects.

RANUNCULACEÆ.

Clematis virginiana L. Winneshiek, Allamakee, and Scott Cos. Woods, infrequent.

Anemone patens L., var. *nuttalliana* Gray. Winneshiek and Allamakee Cos. High prairies, common.

A. cylindrica Gray. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Frequent in open woods.

A. virginiana L. Winneshiek and Allamakee Cos. Rich woods, frequent.

A. pennsylvanica L. Winneshiek, Allamakee, and Scott Cos. Frequent in open woods.

A. nemorosa L. Winneshiek Co. Common in woods.

Hepatica acutiloba DC. Winneshiek, Allamakee, Clayton, and Scott Cos. Rocky woods, common.

Anemonella thalictroides Spach. Winneshiek and Allamakee Cos. Woods, frequent.

Thalictrum dioicum L. Winneshiek, Allamakee, Clayton, and Scott Cos. Rocky woods, frequent.

T. purpurascens L. Winneshiek, Allamakee, and Clayton Cos. In woods and open places, frequent.

Ranunculus aquatilis L., var. *trichophyllus* Gray. Winneshiek Co. Common in pools near springs. This may be *R. circinatus* Sifth.

R. rhomboideus Goldie. Winneshiek Co. One specimen found.

R. abortivus L. Winneshiek and Allamakee Cos. Wet and waste ground, common.

R. fascicularis Muhl. Winneshiek and Scott Cos. Upland woods, frequent.

R. septentrionalis Poir. Winneshiek Co. Moist places, common.

R. pennsylvanicus L. Winneshiek and Allamakee Cos. In Allamakee Co., in sandy soil along the Mississippi river.

Isopyrum biternatum T. & G. Winneshiek and Scott Cos. Woods.

Caltha palustris L. Winneshiek Co. Wet places, not common.

Aquilegia canadensis L. Winneshiek, Allamakee, Clayton, Dubuque, and Scott Cos. Woods, common.

Actæa spicata L. var. *rubra* Ait. Winneshiek Co. Woods, less frequent than the following.

A. alba Bigel. Winneshiek Co. Wooded hillsides, common.

Hydrastis canadensis L. One specimen noted. Winneshiek Co.

MENISPERMACEÆ.

Menispermum canadense L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Woods, frequent.

BERBERIDACEÆ.

Caulophyllum thalictroides Mx. Winneshiek, Allamakee, and Dubuque Cos. Upland woods, frequent.

Podophyllum peltatum L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rich upland woods, common.

NYMPHÆACEÆ.

Nelumbo lutea Pers. Allamakee, and Clayton Cos. Very common in the sloughs of the Mississippi river.

Nymphæa odorata. Ait. Winneshiek and Allamakee Cos. Ponds and sloughs, frequent.

Nuphar advena Ait. Winneshiek and Allamakee Cos. Ponds, frequent.

PAPAVERACEÆ.

Sanguinaria canadensis L. Winneshiek, Allamakee, Clayton, and Scott Cos. Rich woods, frequent.

Dicentra cucullaria DC. Winneshiek, Allamakee, and Scott Cos. Rich woods, common.

CRUCIFERÆ.

Dentaria laciniata Muhl. Winneshiek and Scott Cos. Rich woods, frequent.

Cardamine rhomboidea DC. Winneshiek Co. Damp soil, frequent.

C. hirsuta L. Winneshiek and Allamakee Cos. Damp soil, frequent.

Arabis canadensis L. Winneshiek, Allamakee, and Clayton Cos. Woods, frequent.

A. confinis Watson. Winneshiek and Allamakee Cos. Woods, frequent.

A. lyrata L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rolling woods, common.

A. dentata T. & G. Winneshiek Co. Woods, infrequent.

Draba caroliniana Walt. Winneshiek Co. Rocky woods, infrequent.

Camalina sativa Crantz. Winneshiek Co. Frequent in flax fields.

Nasturtium officinale R. Br. Winneshiek Co. Wet soil, frequent.

N. palustre DC. Winneshiek, Allamakee, Clayton, Dubuque, and Clinton Cos. Wet soil, margins of ponds and waterways, common.

N. armoracia Fries. Winneshiek, Allamakee, and Dubuque Cos. A frequent escape.

Erysimum cheiranthoides L. Winneshiek, Allamakee, and Dubuque Cos.

Sisymbrium canescens Nutt. Winneshiek Co.

S. officinale Scop. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Waste places, common.

S. altissimum L. Allamakee, Clayton, and Dubuque Cos. Frequent in waste places along or near railways.

Brassica sinapistrum Boiss. Winneshiek Co. Waste places, frequent.

B. nigra Koch. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Fields and waste places, common.

Capsella bursa-pastoris Moench. Winneshiek Co. Waste places, common.

L. epidium intermedium Gray. Winneshiek, Allamakee, Clayton, Dubuque, Jackson, Clinton and Scott Cos. Waste places, common.

CAPPARIDACEÆ.

Polanisia trachysperma T. & G. Winneshiek, Allamakee, Clayton, Dubuque and Jackson Cos. Sandy soil along waterways, common.

CISTACEÆ.

Helianthemum canadense Mx. Winneshiek and Allamakee Cos. Prairies, frequent.

VIOLACEÆ.

Viola pedata L. Winneshiek Co. Open places, frequent.

V. palmata L., var. *cucullata* Gray. Winneshiek, Allamakee, Dubuque, Clinton and Scott Cos. Fields and woods, common.

V. pubescens Ait. Winneshiek, Allamakee and Scott Cos. Woods, common.

V. canina L., var. *muhlenbergii* Gray. Winneshiek and Allamakee Cos. Damp woods, infrequent.

CARYOPHYLLACEÆ.

Saponaria officinalis L. Winneshiek and Allamakee Cos. Waste places. A frequent escape.

S. vaccaria L. Winneshiek Co. Waste places, infrequent.

Silene stellata Ait. Winneshiek and Allamakee Cos. Woods. frequent.

S. nivea Otth. Winneshiek and Allamakee Cos. Along river, infrequent.

S antirrhina L. Winneshiek Co. Fields, frequent.

Lychnis githago Lam. Winneshiek Co. Waste places, infrequent.

Arenaria lateriflora L. Winneshiek Co.

Stellaria media Smith. Winneshiek Co.

S. lonigfolia Muhl. Winneshiek Co.

Cerastium arvense L. Winneshiek Co.

C. nutans Raf. Winneshiek and Allamakee Cos.

PORTULACACEÆ.

Portulaca oleracea L. Winneshiek, Allamakee, Clayton and Scott Cos. Fields and waste places, common.

Claytonia virginica L. Winneshiek Co. Woods, frequent.

HYPERICACEÆ.

Hypericum ascyron L. Winneshiek, Allamakee and Clayton Cos. Prairie and upland woods, infrequent.

H. cistifolium Lam. Dubuque Co. Along the railway, frequent.

H. maculatum Walt. Winneshiek Co. Woods and open places, frequent.

MALVACEÆ.

Malva crispa L. Winneshiek Co. One specimen noted.

M. rotundifolia L. Winneshiek, Allamakee, Clayton, Dubuque and Jackson Cos. Waste places near dwellings, common.

Napœa dioica L. Winneshiek and Allamakee Cos. Frequent in the valley of the Upper Iowa river.

Abutilon avicennœ Gaertn. Winneshiek and Allamakee Cos. Fields and waste places, frequent.

TILIACEÆ.

Tilia americana L. Winneshiek, Allamakee, Clayton, Dubuque and Scott Cos. Rich woods, common.

LINACEÆ.

Linum sulcatum Riddell. Allamakee Co. Prairies, frequent.

L. usitatissimum L. Clayton and Dubuque Cos. Waste places along railway, infrequent.

GERANIACEÆ.

Geranium maculatum L. Winneshiek, Allamakee and Clayton Cos. Rich woods, frequent.

Oxalis violacea L. Winneshiek Co. Fields, common.

O. corniculata L., var. *stricta* Sav. Winneshiek, Allamakee, Clayton, Dubuque, and Clinton Cos. Fields and woods, common.

Impatiens pallida Nutt. Winneshiek and Clayton Cos. Rich soil along streams, common.

I. fulva Nutt. Winneshiek and Allamakee Cos. With the preceding.

RUTACEÆ.

Xanthoxy'um americana Mill. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Woods, frequent.

Ptelea trifoliata L. Rock Island Arsenal grounds.

CELASTRACEÆ.

Euonymus atropurpureus Jacq. Winneshiek and Allamakee Cos. Upland woods, frequent.

RHAMNACEÆ.

Ceanothus americanus L. Winneshiek, Allamakee, Clayton, Dubuque, and Jackson Cos. Woods, frequent.

VITACEÆ.

Vitis riparia Mx. Winneshiek, Allamakee, Clayton, Dubuque, and Jackson Cos. Woods, common.

Ampelopsis quinquefolia Mx. Winneshiek, Clayton, and Dubuque Cos. Woods, common.

SAPINDACEÆ.

Acer spicatum Lam. Clayton Co. Bluffs, infrequent. Specimen sent by Prof. B. Fink.

A. saccharinum Wang. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Frequent along rivers in rolling woods.

A. dasycarpum Ehrh. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Low grounds, common.

Negunao aceroides Moench. Winneshiek, Allamakee, Clayton, Dubuque, and Clinton Cos. Low grounds, common

Staphylea trifolia L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rocky woods, frequent.

ANACARDIACEÆ.

Rhus typhina L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rolling woods, frequent.

R glabra L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Uplands, common.

POLYGALACEÆ.

Polygala senaga L. Winneshiek Co. Woods, frequent.

LEGUMINOSÆ.

Baptisia leucophæa Nutt. Winneshiek and Allamakee Cos. Open woods and pastures, frequent.

B leucantha T. & G. Winneshiek and Allamakee Cos. Fields and woods, common.

Lupinus perennis L. Winneshiek Co.

Trifolium arvense L. Winneshiek Co. Fields, infrequent.

T. pratense L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Fields and waste places, common.

T. repens L. Winneshiek and Allamakee Cos. Pastures and waste places, common.

T. hybridum L. Winneshiek Co. Fields and waste places, infrequent.

Melilotus officinalis Willd. Winneshiek Co. Waste places, frequent.

M. alba Lam. Winneshiek, Allamakee, Clayton, Dubuque, and Scott Cos. Waste places, common.

Amorpha canescens Nutt. Winneshiek, Allamakee, Clayton, Dubuque, and Jackson Cos. Dry soil, common.

A. fruticosa L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Along waterways, frequent.

Petalostemon violaceus Mx. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Prairies, common.

P. candidus Mx. Winneshiek, Allamakee, and Dubuque Cos. With the preceding.

Tephrosia virginiana Pers. Winneshiek, Allamakee, and Jackson Cos. Sandy soil, frequent.

Robinia pseudacacia L. Winneshiek, Allamakee, and Jackson Cos. Introduced, waste places.

Astragalus canadensis L. Winneshiek and Clayton Cos. Frequent.

Desmodium acuminatum DC. Winneshiek, Allamakee, and Clayton Cos. Woods, frequent.

D. canadense DC. Winneshiek, Clayton, and Dubuque Cos.

Lespedeza capitata Mx. Winneshiek Co.

Vicia cracca K. Winneshiek Co. One specimen in my collection.

V. americana Mull. Winneshiek and Allamakee Cos. Woods, frequent.

Lathyrus venosus Muhl. Winneshiek Co. Woods, frequent.

Apios tuberosa Moench. Allamakee Co. Woods, frequent.

Strophostyles angulosa Ell. Clayton, Dubuque, Jackson, and Scott Cos. Sandy soil, common.

Cassia marylandica L. Dubuque Co. Woods, infrequent.

C. chamæcrista L. Winneshiek, Allamakee, Dubuque, and Jackson Cos. Fields and waste places, common.

Cercis canadensis L. Scott Co. Rolling woods, frequent.

Gymnocladus canadensis Lam. Dubuque Co. Woods along the river, infrequent.

Gleditschia triacanthos L. Allamakee, Clayton, Dubuque, Clinton, and Jackson Cos. Rich woods, frequent.

ROSACEÆ.

Prunus americana Mars. Winneshiek, Allamakee, and Clayton Cos. Thickets, frequent.

P. serotina Ehrh. Winneshiek, Allamakee, and Dubuque Cos. Rich woods, frequent.

P. virginiana L. Winneshiek, Allamakee, and Dubuque Cos. Thickets, frequent.

Spiraea aruncus L. Dubuque and Muscatine Cos. Along river, frequent.

Physocarpus opulifolius Maxim. Winneshiek, Allamakee, and Clayton Cos. Rich woods, frequent.

Rubus occidentalis L. Winneshiek, Allamakee, Clayton, Dubuque, and Jackson Cos. Borders of fields and in woods, frequent.

R. villosus Ait. Winneshiek and Jackson Cos. Woods, frequent.

Geum album Gmelin. Winneshiek, Allamakee, and Clayton Cos. Borders of fields and woods, common.

G. macrophyllum Wild. Winneshiek. A few collected.

G. triflorum Pursh. Winneshiek and Allamakee Cos. Rocky woods, infrequent.

Fragaria virginiana Mill. Winneshiek, Allamakee, and Clayton Cos. Fields and woods, common.

F. vesca L. Winneshiek and Allamakee Cos. Woods, common.

Potentilla arguta Pursh. Winneshiek and Allamakee Cos. Roadsides and prairies, frequent.

P. norvegica L. Winneshiek, Allamakee, Clayton and Dubuque Cos. Fields, frequent.

P. fruticosa L. Allamakee Co. Common on top of a bluff facing the Upper Iowa river. Also in Winneshiek Co.

P. canadensis L. Winneshiek and Allamakee Cos. Fields, common.

Agrimona eupatoria L. Winneshiek Co. Woods, common.

Rosa humilis Marsh. Winneshiek, Dubuque, Allamakee, and Jackson Cos. Prairie and fields, common.

R. blanda Ait. Winneshiek and Allamakee Cos. Fields and woods, frequent.

Pyrus coronaria L. Allamakee Co. Thickets, common.

Crataegus coccinea L. Allamakee Co. Thickets, common.

C. tomentosa L. Winneshiek, Allamakee, and Clayton Cos. Thickets, common.

C. crus-galli L. Winneshiek, Allamakee, Clayton and Scott Cos. Thickets, common.

Amelanchier canadensis T. & G. Winneshiek and Allamakee Cos. Rocky woods, frequent.

SAXIFRAGACEÆ.

Saxifraga pennsylvanica L. Winneshiek and Allamakee Cos. Rich soil, meadows and open woods, frequent.

Mitella diphylla L. Winneshiek Co. Rich woods, frequent.

Heuchera hispida Pursh. Winneshiek, Allamakee, Clayton and Scott Cos. Meadows, frequent.

Ribes cynosbati L. Winneshiek, Clayton and Dubuque Cos. Woods, frequent.

R. gracile Mx. Winneshiek, Allamakee and Dubuque Cos. Woods, common.

R. floridum L'Her. Winneshiek, Allamakee and Clayton Cos. Woods, frequent.

CRASSULACEÆ

Penthorum sedoides L. Winneshiek Co. Wet ground, frequent.

HAMAMELIDEÆ.

Hamamelis virginiana L. Clayton Co. In a ravine below the pictured rocks south of McGregor.

ONAGRACEÆ.

Epilobium angustifolium L. Dubuque Co. Common in open woods.

E. coloratum Muhl. Winneshiek Co. Wet soil, frequent.

Gaura coccinea Nutt. Dubuque Co. Common.

Œnothera biennis L. Winneshiek, Clayton, Dubuque and Jackson Cos. Fields, common.

Œ. serrulata Nutt. Winneshiek and Allamakee Cos. Prairies and woods, frequent.

Circæ lutetiana L. Winneshiek and Allamakee Cos. Woods, common.

C. alpina L. Clayton Co. Woods along river, infrequent.

CUCURBITACEÆ.

Echinocystis lobata T. & G. Winneshiek, Allamakee, Clayton and Clinton Cos. Woods, common.

FICOIDEÆ.

Mollugo verticillata L. Allamakee and Clayton Cos. Sandy shores, common.

UMBELLIFERÆ.

Daucus carota L. Dubuque Co. Common along railway.

Heracleum lanatum Mx. Winneshiek and Allamakee Cos. Upland woods, frequent.

Cicuta maculata L. Winneshiek, Allamakee, Clayton and Dubuque Cos. Wet places, common.

Pastinaca sativa L. Dubuque Co. Waste ground.

Pimpinella integerrima Benth. & Hook. Winneshiek Co. Woods, frequent.

Cryptotænia canadensis DC. Winneshiek Co.

Sium cicutæfolium Gmelin. Winneshiek, Allamakee, Clayton and Dubuque Cos. In water or wet ground, frequent

Conium maculatum L Winneshiek Co. Along a ravine, introduced, infrequent.

Zizia aurea Koch. Winneshiek and Allamakee Cos. Rich soil, common.

Osmorrhiza longistylis DC Allamakee Co. Woods, frequent

O. brevistylis DC Winneshiek and Clayton Cos. Woods, frequent

Eryngium yuccæfolium Mx Winneshiek Co. Prairies, common

Saniculama rylandica L. Winneshiek, Clayton and Dubuque Cos. Woods, common.

ARALIACEÆ.

Aralia racemosa L. Winneshiek, Clayton and Dubuque Cos. Rocky woods, frequent

A. nudicaulis L Winneshiek and Allamakee Cos. Rocky woods, frequent.

A. quinquefolia Decs. & Planch. Winneshiek Co. Woods, infrequent.

CORNACEÆ.

Cornus paniculata L'Her. Winneshiek, Allamakee, and Clayton Cos. Woods and borders, frequent.

CAPRIFOLIACEÆ.

- *Sambuscus canadensis* L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Fields and woods, common.

S. racemosa L. Winneshiek and Clayton Cos. Rocky woods, frequent.

Viburnum lentago L. Winneshiek, Allamakee, and Dubuque Cos. Woods, frequent.

Triosteum perfoliatum L. Winneshiek, Allamakee, and Clayton Cos. Open woods, frequent.

Linnæa borealis Gronov. Winneshiek Co.

Symphoricarpos occidentalis Hook. Winneshiek Co.

Lonicera glauca Hill. Winneshiek and Allamakee Cos. Woods, infrequent.

L. sullivantii Gray. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Woods, frequent.

Diervilla trifida Moench. Winneshiek Co. Woods near the base of cliffs, frequent.

RUBIACEÆ.

Cephalanthus occidentalis L. Allamakee, Clayton, Clinton, and Jackson Cos. Low woods, frequent.

Galium apariæ L. Winneshiek and Allamakee Cos. Damp woods, frequent.

G. boreale L. Winneshiek and Allamakee Cos. Woods, frequent.

G. concinnum T. & G. Winneshiek and Allamakee Cos. Woods, common.

VALERIANACEÆ.

Valeriana edulis Nutt. Winneshiek Co. Damp places, frequent.

COMPOSITÆ.

Vernonia fasiculata Mx. Winneshiek, Allamakee, Dubuque, and Jackson Cos. Low grounds, frequent.

Eupatorium purpureum L. Winneshiek, Clayton, and Dubuque Cos. Woods, frequent.

E. ageratoides L. Winneshiek Co. Woods, common.

E. perfoliatum L. Winneshiek Co.

E. altissimum L. Winneshiek Co.

Kuhnia eupatorioides L. Winneshiek Co. Dry soil, common.

Liatris scariosa Willd. Winneshiek Co. Prairies.

Solidago bicolor L. Winneshiek Co. One specimen collected.

S. rigida L. Winneshiek Co. Prairies, common.

S. ulmifolia Muhl. Winneshiek Co. Woods, common.

S. latifolia L. Allamakee Co. Woods, frequent.

S. serotina Ait. Winneshiek, Clayton, and Dubuque Cos.

S. canadensis L. Winneshiek, Clayton, and Dubuque Cos.

S. nemoralis Ait. Winneshiek and Dubuque Cos.

Aster sericeus Vent. Winneshiek Co.

A. shortii Hook. Winneshiek Co. One specimen noted.

A. multiflorus Ait. Winneshiek Co. Waysides, common.

A. tradescanti L. Winneshiek Co.

A. novæ-angliæ L. Winneshiek Co.

A. azureus Lindl. Winneshiek Co.

A. sagittifolius Willd. Winneshiek, Allamakee, Clayton, and Dubuque Cos,

Erigeron bellidifolius Muhl. Winneshiek Co.

E. strigosus Muhl. Winneshiek Co.

E. philadelphicus L. Winneshiek Co.

E. canadensis L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Fields and waste places, common.

E. annuus Pers. Winneshiek, Allamakee, Clayton, and Dubuque Cos.

Antennaria plantaginifolia Hook. Winneshiek, Allamakee, and Clayton Cos. Fields and open woods, common.

Polymnia canadensis L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Along the base of wooded cliffs, common.

Silphium perfoliatum L. Winneshiek, Allamakee, and Dubuque Cos.

S. laciniatum L. Winneshiek, Allamakee, and Dubuque Cos. Prairies and borders of woods, common.

S. integrifolium Mx. Dubuque Co.

Parthenium integrifolium L. Winneshiek, Allamakee, and Dubuque Cos. Fields, frequent.

Iva xanthiifolia Nutt. Winneshiek Co. Waste places, infrequent.

Ambrosia artemisiæfolia L. Winneshiek, Allamakee, Clayton, Dubuque, and Jackson Cos. Fields and waste places, common.

A. trifida L. Winneshiek, Allamakee, and Jackson Cos. Damp soil, waste places, common. The var. *integrifolia* T. G., frequently found.

Xanthium canadense Mill. Winneshiek, Allamakee, Clayton, Dubuque, Jackson, and Clinton Cos. Fields and waste places, common.

Heliopsis scabra Dunal. Winneshiek, Allamakee, and Clayton Cos. Frequent.

Rudbeckia triloba L. Winneshiek and Dubuque Cos. Open woods, frequent.

R. hirta L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Woods, frequent.

R. laciniata L. Winneshiek Co.

Lepachys pinnata T. & G. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Prairies, common.

Helianthus annuus L. Winneshiek, Allamakee, Clayton, and Jackson Cos. Waste places, frequent.

H. petiolaris Nutt. Dubuque Co. Along the railroad, one specimen.

H. occidentalis Ridd. Winneshiek Co.

H. grosse-serratus Mart. Winneshiek Co. Rich soil, common.

H. maximiliani Schrad. Dubuque Co. A few along railroad.

H. tuberosus L. Winneshiek Co. Woods, frequent.

Coreopsis palmata Nutt. Winneshiek, Allamakee, and Clayton Cos. Prairies, common.

Bidens frondosis L. Winneshiek, Clayton, Dubuque, and Clinton Cos. Wet grounds, common.

B. connata Muhl. Winneshiek Co. Wet grounds, common.

B. cernua L. Winneshiek Co. Wet grounds, common.

Helenium antumnale L. Winneshiek, Allamakee, Clinton, and Scott Cos. Alluvial soil, frequent.

Anthemis cotula DC. Winneshiek, Allamakee, Clayton, Dubuque, Jackson, Clinton, and Scott Cos. Waste places, common.

Achillea millefolium L. Winneshiek and Dubuque Cos. Meadows and open woods, common.

Chrysanthemum leucanthemum L. Allamakee and Dubuque Cos. Along railroad and in open woods, infrequent.

Tanacetum vulgare L. Winneshiek and Allamakee Cos. Waysides and waste places, frequent.

Artemisia blennis Willd. Winneshiek, Dubuque, and Jackson Cos. Waste places, frequent.

A. ludoviciana Nutt. Winneshiek, Allamakee, and Dubuque Cos.

A. caudata Mx. Winneshiek Co.

Senecio aureus L., var. *balsamitæ* T. & G. Winneshiek, Allamakee, and Scott Cos. Woods, frequent.

Cacalia suaveoleus L. Winneshiek Co. Woods, infrequent.

C. reniformis Muhl. Winneshiek and Allamakee Cos. Woods, frequent.

C. tuberosa Nutt. Allamakee Co. Wet prairies, frequent.

Erechtites hieracifolia Raf. Winneshiek Co. Open places, frequent.

Arctium lappa L. Winneshiek, Clayton and Dubuque Cos. Fields and waste places, frequent.

Cnicus lanceolatus Hoffm. Winneshiek, Allamakee, Clayton, Dubuque and Clinton Cos. Fields and open woods, frequent.

C. altissimus Willd. Winneshiek and Scott Cos.

Krigia amplexicaulis Nutt. Winneshiek and Allamakee Cos. Rich upland woods, common.

Hieracium canadense Mx. Winneshiek Co.

Prenanthes alba L. Winneshiek Co.

Taraxacum officinale Weber. Winneshiek, Allamakee, Clayton, Dubuque, and Clinton Cos. Roadsides and fields, common.

Lactuca scariola L. Winneshiek and Dubuque Cos. Waste places, infrequent.

L. canadensis L. Winneshiek Co.

L. acuminata Gray. Clayton and Dubuque Cos.

Sonchus asper Vill. Winneshiek and Dubuque Cos.

LOBELIACEÆ.

Lobelia syphilitica L. Winneshiek Co. Dampsoil, common.

L. spicata Lan. Winneshiek and Allamakee Cos. Fields, frequent.

CAMPANULACEÆ.

Specularia perfolia A. DC. Winneshiek and Allamakee Cos.

Campanula rotundifolia L. Winneshiek, Allamakee, Clayton, Dubuque, and Jackson Cos. Woods at the base of cliffs, frequent.

C. aparinoides Pursh. Winneshiek Co. A few specimens collected.

C. americana L. Winneshiek, Clayton, and Dubuque Cos. Rich soil, woods, frequent.

ERICACEÆ.

P. secunda L. Winneshiek Co. One specimen received in exchange. The only locality known in the state. Reported by Holway and Shimek.

PRIMULACEÆ.

Eodecatheon media L. Winneshiek and Scott Cos. Woods frequent.

Steironoma ciliatum Raf. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Open woods, frequent.

S. lanceolatum Gray. Allamakee Co. Alluvial soil along the Mississippi river.

OLEACEÆ.

Fraxinus americana L. Winneshiek, Allamakee, Clayton, and Clinton Cos. Rich woods, frequent.

Syringa vulgaris L. Dubuque Co. Many specimens were found along the railroad.

APOCYNACEÆ.

Apocynum androsæmifolium L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Fields and waste places, frequent.

ASCLEPIADACEÆ.

Asclepias tuberosa L. Winneshiek, Allamakee, and Clayton Cos. Fields, frequent.

A. incarnata L. Winneshiek, Allamakee, and Clayton Cos. Wet ground, frequent.

A. cornuti Dec. Winneshiek, Allamakee, Clayton, Dubuque, and Jackson Cos. Fields, common.

A. phytolaccoidea Pursh. Winneshiek Co.

A. verticillata L. Winneshiek, Clayton and Dubuque Cos. Open woods, frequent.

Acerates viridiflora Ell. Allamakee Co.

GENTIANACEÆ.

Gentiana quinquefolia Lam., var. *occidentalis* Gray. Winneshiek Co.

G. puberula Mx. Winneshiek Co.

G. alba Muhl. Winneshiek Co. One specimen.

POLEMONIACEÆ.

Phlox pilosa L. Winneshiek and Scott Cos. Prairies, frequent.

P. divaricata L. Winneshiek, Allamakee and Clayton Cos. Woods, frequent.

Polemonium reptans L. Winneshiek, Allamakee and Scott Cos. Rich woods, frequent.

HYDROPHYLLACEÆ.

Hydrophyllum virginicum L. Winneshiek and Allamakee

H. appendiculatum Mx. Winneshiek Co. Rocky woods, frequent.

Ellisia nyctelea L. Winneshiek Co. Low ground, common.

BORRAGINACEÆ.

Cynoglossum officinale L. Allamakee and Scott Cos. Open woods, infrequent.

Echinospermum virginicum Lehm. Winneshiek Co.

E. redowskii occidentale Wats. Winneshiek Co. Frequent.

Mertensia virginica DC. Winneshiek and Scott Cos. Damp woods, frequent.

M. paniculata Don. Winneshiek Co· Received in exchange, collected by Holway.

Lithospermum latifolium Mx. Winneshiek Co.

L. hirtum Lehm. Winneshiek and Allamakee Cos. Sandy woods, frequent.

L. canescens Lehm. Winneshiek, Allamakee and Scott Cos.

L angustifolium Mx. Winneshiek Co.

Onosmodium carolinianum DC. Winneshiek and Allamakee Cos. Pastures and open woods, frequent.

CONVOLVULACEÆ.

Ipomœa pandurata Meyer. Winneshiek Co.

Convolvulus sepium L. Allamakee, Clayton, Dubuque and Clinton Cos. Fields and thickets, frequent.

Cuscuta glomerata Choisy. Winneshiek, Allamakee and Jackson Cos. Fields and upland thickets, frequent.

C. tenuiflora Eng. Winneshiek Co. Woods, frequent.

SOLANACEÆ.

Solanum nigrum L. Allamakee, Clayton, Dubuque, Clinton and Scott Cos Fields and woods, common

Physalis virginiana Mill. Winneshiek, Allamakee and Clayton Cos

P. lanceolata Mx. Winneshiek Co. Prairies, frequent.

P. lanceolata MX., var. lævigata Gray. Allamakee Co.

Datura tatula L. Allama ee and Dubuque Cos. Waste places, common.

SCROPHULARIACEÆ.

Verbascum thapsus L. Winneshiek, Allamakee, Clayton, Dubuque, Jackson and Scott Cos. Fields and woods, common.

Linaria vulgaria Mill. Winneshiek and Clayton Cos. Waste places, frequent.

Scrophularia nodosa L., var. *marilcanda* Gray. Winnesheik, Allamakee, Clayton and Dubuque Cos. Open woods, frequent

Chelone glabra L. Winneshiek Co.

Mimulus ringens L. Winnesheik, Allamakee, Clayton and Dubuque Cos. Wet ground, river banks, frequent.

M. jamesii Torr. Winneshiek Co. .Calcareous springs, frequent.

Gratiola virginiana L. Winneshiek Co. Upland woods, frequent.

Veronica virginica L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Woods, common.

V. anagallis L. Winneshiek and Allamakee Cos. Wet grounds near springs, common.

V. peregrina L. Winneshiek Co. Wet soil, common.

Gerardia tenuifolia Vahl. Winneshiek Co. Fields and woods, common.

Castilleia coccinea Spreng. Winneshiek Co. Woods, frequent.

Pedicularis canadensis L. Winneshiek, Allamakee, and Clayton Cos. Prairies, common.

P. lanceolata Mx. Wet ground, infrequent.

VERBENACEÆ.

Verbena urticiefolia L. Winneshiek, Allamakee, and Dubuque Cos. Fields and open woods, frequent.

V. angustifolia Mx. Allamakee Co. Sandy soil, frequent.

V. hastata L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Waste grounds, common.

V. stricta Vent. Winneshiek, Allamakee, and Clayton Cos. Sandy soil, frequent.

V. bracteosa Mx. Winneshiek, Allamakee, and Clayton Cos. Pastures and waste places, frequent.

Lippia lanceolata Mx. Clayton, Dubuque, and Clinton Cos. Wet soil along river, common.

Phryma leptostachya L. Winneshiek, Allamakee, and Clayton cos. Rich open woods, common.

LABIATEÆ.

Isanthus cœruleus Mx. Winneshiek and Scott cos. Open woods, frequent.

Mentha canadensis L. Winneshiek and Allamakee Cos.

Lycopus sinuatus Ell. Winneshiek Co.

Pycnanthemum lanceolatum Pursh. Winneshiek Co.

P. linifolium Pursh. Jackson Co.

Hedeoma pulegioides Pers. Allamakee Co. Open woods, common.

H. hispida Pursh. Winneshiek Co. Dry soil, common.

Monarda fistulosa L. Winneshiek, Allamakee, Clayton and Dubuque Cos. Waste places, common.

M. punctata L. Dubuque Co. Frequent along railroad.

Lophanthus scrophulariæfolius Benth. Winneshiek Co. Open woods.

Nepeta cataria L. Winneshiek, Allamakee, Clayton, Dubuque, and Scott Cos. Roadsides and waste places, common.

N. glechoma Benth. Winneshiek Co. Waste places, infrequent.

Blephilia hirsuta Benth. Winneshiek Co. Woods, frequent.

Scutellaria lateriflora L. Winneshiek Co.

S. versicolor Nutt. Winneshiek and Allamakee Cos. Woods, infrequent.

S. parvula Mx. Winneshiek, Allamakee, and Scott Cos.

Brunella vulgaris L. Winneshiek, Allamakee, and Dubuque Cos.

Physostegia virginiana Benth. Winneshiek Co.

Leonurus cardiaca L. Winneshiek Co. Waste places, frequent.

Stachys palustris L. Winneshiek Co.

S. aspera Mx. Dubuque Co.

Galeopsis tetrahit L. Winneshiek Co. One specimen collected.

AMARANTACEÆ.

Amarantus albus L. Winneshiek, Allamakee, Clayton, Clinton, and Scott Cos. Wayside and waste places, frequent.

A. blitoides Watson. Allamakee Co.

CHENOPODIACEÆ.

Chenopodium album L. Winneshiek, Allamakee, and Clinton Cos.

C. botrys L. Dubuque Co. Waste places, frequent.

Salsola kali L. var. *targus* DC. Dubuque Co. A few found in waste places.

POLYGONACEÆ.

Rumex britannica L. Winneshiek and Allamakee Cos. Rich soil, common.

R. altissimus Wood. Winneshiek, Allamakee, and Clayton Cos. Rich soil, common.

R. verticillatus L. Winneshiek and Allamakee Cos. Wet ground, frequent.

R. obtusifolius L. Winneshiek Co.

R. crispus L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rich soil, wayside and waste places, common.

R. acetosella L. Winneshiek and Allamakee Cos. Cultivated fields, frequent.

Polygonum pennsylvanicum L. Winneshiek and Clayton Cos. Damp soil, common.

P. amphibium L. Allamakee Co. Along river.

P. aviculare L. Winneshiek Co. Waste places, common.

P. sagittatum L. Winneshiek Co. Margins of ponds and streams, frequent.

P. convolvulus L. Dubuque Co.

P. dumetorum L., var. *scandens* Gray. Winneshiek, Allamakee, and Clayton Cos. Fields and woods, common.

P. tenue Mx. Winneshiek Co.

ARISTOLOCHIACEÆ.

Asarum canadense L. Winneshiek, Allamakee, and Clayton Cos. Wooded bluffs, frequent.

THYMELÆACEÆ.

Dirca palustris L. Winneshiek Co.

EUPHORBIACEÆ.

Euphorbia maculata L. Winneshiek, Allamakee, Clayton, Dubuque, Jackson, and Clinton Cos. Waysides, common.

E. preslii Guss. Winneshiek, Allamakee, and Dubuque Cos. Waysides, common.

E. cyparissias L. Allamakee and Scott Cos. Near old cemetery.

URTICACEÆ.

Ulmus fulva Mx. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rich woods, frequent.

U. americana L. Winneshiek, Allamakee, Clayton, Dubuque, Jackson, Clinton, and Scott Cos. Woods, common.

Celtis occidentalis L. Winneshiek, Allamakee, and Clayton Cos. Rich woods, frequent.

Morus rubra L. Clayton Co. Near river, infrequent.

Urtica gracilis Ait. Winneshiek and Allamakee Cos. Alluvial soil, frequent.

Pilea pumila Gray. Winneshiek and Clayton Cos. Rich woods or waste places, frequent.

Laportea canadensis Gaud. Alluvial soil, frequent.

Parietaria pennsylvanica Muhl. Winneshiek, Allamakee, and Dubuque Cos. Woods, frequent.

PLANTANACEÆ.

Plantanus occidentalis L. Jackson Co. Along Mississippi river.

JUGLANDACEÆ.

Juglans cinerea L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rich soil, frequent.

J. nigra L. Winneshiek, Allamakee, Clayton, Dubuque, Jackson, and Scott Cos. Rich soil, frequent.

Carya alba Nutt. Winneshiek, Allamakee, Clinton, and Scott Cos. Uplands, frequent

C. amara Nutt. Winneshiek Co. Low grounds, frequent.

CUPULIFERÆ.

Betula nigra L. Allamakee, Clayton, Dubuque, Jackson, and Clinton Cos. River banks, common.

B. papyrifera Mars. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rich woods, common.

Corylus americana Walt. Winneshiek, Allamakee, and Dubuque Cos. Uplands, common.

Ostrya virginica Willd. Winneshiek, Allamakee, and Clayton Cos. River bluffs, frequent.

Carpinus caroliniana Walt. Allamakee, Clayton, and Dubuque Cos. Rolling woods, frequent.

Quercus alba L. Winneshiek, Allamakee, and Clayton Cos. Uplands, frequent.

Q. macrocarpa Mx. Winneshiek, Allamakee, Claytcn, and Dubuque Cos. Upland woods, common.

Q. rubra L. Winneshiek, Allamakee, and Clayton Cos. Uplands and lowlands, frequent.

Q. coccinea Wang. Allamakee, Dubuque, Jackson, and Scott Cos. Uplands, common.

SALICACEÆ.

Salix humilis Marsh. Winneshiek Co. Prairies, frequent.

Populus tremuloides Mx. Winneshiek, Allamakee, and Dubuque Cos.

P. monilifera Ait. Winneshiek, Allamakee, Clayton, Dubuque, Jackson, and Clinton Cos. Along streams, common.

CONIFERÆ.

Pinus strobus L. Winneshiek, Allamakee, and Clayton Cos. Summit of bluffs along rivers, frequent.

Juniperus cummunis L. Winneshiek, Allamakee, and Dubuque Cos. Dry soil, frequent.

J. virginiana L. Winneshiek, Allamakee, and Clayton Cos. With the preceding.

Taxus canadensis Willd. Winneshiek, and Dubuque Cos. A decumbent bush under the pines.

HYDROCHARIDACEÆ.

Elodea canadensis Mx. Winneshiek and Allamakee Cos. Ponds, frequent.

Vallisneria spiralis L. Scott Co. In Mississippi river.

ORCHIDACEÆ.

Liparis liliifolia Richard. Winneshiek Co.

Goodyera pubescens R. Br. Winneshiek Co. One specimen noted.

Habenaria bracteata R. Br. Winneshiek Co. Two specimens found in deep woods.

Cypripedium pubescens Willd. Winneshiek and Allamakee Cos. Rich woods, frequent.

IRIDACEÆ.

Iris versicolor L. Winneshiek and Allamakee Cos. Wet places, frequent.

Belamcanda chinensis Adams. Dubuque Co. Frequent along railway.

Sisyrinchium angustifolium Mill. Winneshiek Co. Fields and waysides, frequent.

AMARYLLIDACEÆ.

Hypoxis erecta L. Winneshiek Co. Rich meadows, frequent.

DIOSCORIACEÆ.

Dioscorea villosa L. Winneshiek and Dubuque Cos. Thickets, frequent.

LILIACEÆ:

Smilax herbacea L. Winneshiek, Allamakee, and Dubuque Cos. Alluvial soil, frequent.

S. hispida Muhl. Allamakee, Clayton, and Dubuque Cos. Thickets, frequent.

S. ecirrhata Wats. Winneshiek Co. Woods, frequent.

Allium stellatum Fras. Winneshiek Co. Fields, frequent.

A. tricoccum Ait. Winneshiek and Allamakee Cos. Low woods, infrequent.

A. canadense Kalm. Winneshiek, Allamakee, and Dubuque Cos. Fields, frequent.

Zygadenus elegans Pursh. Allamakee Co. Base of cliffs, frequent.

Polygonatum giganteum Diet. Winneshiek, Clayton, and Dubuque Cos. Alluvial soil, frequent.

Asparagus officinalis L. Winneshiek Co. Waysides and waste places, infrequent.

Smilacina racemosa Desf. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Copses, common.

S. stellata Desf. Winneshiek Co. Frequent.

Maianthemum canadense Desf. Winneshiek Co. Rich woods, frequent.

Uvularia grandiflora Smith. Winneshiek, Allamakee, and Clayton Cos. Rich woods, frequent.

Oakesia sessilifolia Watson. Winneshiek Co. Rich woods, infrequent.

Erythronium albidum Nutt. Winneshiek Co. Rich soil, common.

Lilium philadelphicum L. Winneshiek Co. Prairies and upland woods, infrequent.

L. canadense L. Winneshiek Co.

Trillium erectum L. Winneshiek Co. Rich woods, frequent.

T. nivale Riddell. Winneshiek Co. Rocky woods, frequent.

PONTEDERIACEÆ.

Heteranthera graminea Vahl. Allamakee Co. Frequent in Upper Iowa river.

COMMELINACEÆ.

Tradescantia virginica L. Winneshiek, Allamakee, and Clayton Cos. Rich soil, frequent.

JUNCACEÆ.

Juncus tenuis Willd. Winneshiek, Allamakee, Dubuque, and Jackson Cos. Fields snd waysides, common.

TYPHACEÆ.

Typha latifolia L. Winneshiek and Allamakee Cos. Ponds and river margins, frequent.

Sparganium eurycarpum Englm. Winneshiek Co. Wet places, frequent.

ARACEÆ.

Arisæma triphyllum Torr. Winneshiek, Allamakee, Clayton, Dubuque, and Scott Cos. Rich woods, frequent.

A. dracontium Schott. Winneshiek and Dubuque Cos. Rich woods, infrequent.

Symplocarpus fœtidus Salisb. Winneshiek and Allamakee Cos. Wet ground, infrequent.

LEMNACEÆ.

Spirodela polyrrhiza Schleid. Winneshiek and Dubuque Cos. Ponds and river sloughs, common.

ALISMACEÆ.

Alisma plantago L. Winneshiek and Dubuque Cos. Shallow ponds and ditches, frequent.

Sagittaria variabilis Engl. Winneshiek, Allamakee, Clayon, and Dubuque Cos. Mud flats, ditches, and shallow water, common.

S. heterophylla Pursh. Winneshiek Co. In shallow water, frequent.

NAIADACEÆ.

Potamogeton fluitans Roth. Winneshiek, Allamakee, and Clayton Cos. Common in the Upper Iowa river.

P. pauciflorus Pursh. Winneshiek Co. Frequent.

CYPERACEÆ.

Cyperus esculentus L. Clayton Co. Wet ground, frequent.

Eleocharis palustris R. Br. Winneshiek Co. Wet ground, frequent.

Scirpus lacustris L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Wet ground and in water, common.

S. fluviatilis Gray. Allamakee Co. Very common in the sloughs of the Mississippi river.

S. atrovirens Muhl. Winneshiek, Allamakee, and Dubuque Cos. Wet ground, frequent.

Carex intumescens Rudge. Dubuque Co. Wet woods, frequent.

C. squarrosa L. Clayton and Dubuque Cos. Wet woods, frequent.

C. hystricina Muhl. Winneshiek Co. Wet ground, frequent.

C. pennsylvanica Lam. Winneshiek Co. Dry soil, common.

C. stipata Muhl. Winneshiek Co.

C. vulpinoidea Mx. Winneshiek Co.

C. rosea Schkuhr. Winneshiek Co.

C. cephalophora Muhl. Winneshiek Co.

C. straminea Willd., var. *aptera* Booth. Winneshiek Co. The same as *C. tenera* Dew.

GRAMINEÆ.

Panicum sanguinale L. Winneshiek Co.

P. capillare L. Winneshiek Co.

P. dichotomum L. Winneshiek Co.

P. dichotomum L., var. *villosa* Vasey. Winneshiek Co.

P. latifolium L. Winneshiek, Allamakee, and Clayton Cos. Woods, frequent.

Setaria glauca Beauv. Winneshiek, Clayton, and Dubuque Cos. Waste places, common.

S. viridis Beauv. Winneshiek and Clayton Cos. Waste places, common.

Cenchrus tribuloides L. Dubuque Co. Sandy soil, frequent.

Andropogon furcatus Muhl. Allamakee Co.

Stipa spartea Trin. Winneshiek Co. Prairies, frequent.

Phleum pratense L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Cultivated and frequent in waste places.

Bouteloua racemosa Lag. Allamakee Co. Waysides, frequent.

Kœleria cristata Pers. Winneshiek and Allamakee Cos. Waysides, frequent.

Eragrostis major Host. Winneshiek and Dubuque Cos. Sandy soil, frequent.

E. frankii Meyer. Winneshiek Co. Sandy soil.

Melica mutica Walt. Winneshiek Co.

Poa prutensis L. Winneshiek, Allamakee, and Dubuque Cos. Dry soil, pastures, waysides, common.

Glyceria arundinacea Kunth. Winneshiek Co. Margins of ponds, wet ground, frequent.

Bromus kalmii Gray. Winneshiek Co. Fields, infrequent.

B. secalinus L. Winneshiek Co. Fields and waste places, frequent.

B. ciliatus L., var. *purgans* Gray. Winneshiek, Allamakee, and Jackson Cos. Rich upland woods, frequent.

Agropyrum repens (L.) Beauv. Winneshiek Co. Dry soil, frequent.

Hordeum jubatum L. Winneshiek, Clayton, and Scott Cos. Dry fields, common.

Elymus canadensis L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Prairies and low grounds, common.

E. striatus Willd. Allamakee Co.

Asprella hystrix Willd. Winneshiek, Clayton, and Dubuque Cos. Upland woods, frequent.

EQUISETACEÆ.

Equisetum arvense L. Winneshiek and Allamakee Cos. Wet soil, frequent.

E. hyemale L. Allamakee Co. Wet places, frequent.

E. lævigatum Braun. Waysides and fields, frequent.

FILICES.

Polypodium vulgare L. Clayton Co. Frequent at pictured rocks below McGregor.

Adiantum pedatum L. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rich, upland woods, frequent.

Pteris aquilina L. Winneshiek, Allamakee. and Clayton Cos. Upland woods, frequent.

Cheilanthes lanuginosa Nutt. Allamakee and Dubuque Cos. On the face of cliffs, common locally.

Pellæa atropurpurea Link. Winneshiek, Allamakee, and Dubuque Cos. Cliff crevices, frequent.

Asplenium filix-fœmina Bernh. Winneshiek and Clayton Cos. Woods, frequent.

Camptosorus rhizophyllus Link. Winneshiek, andClayton Cos. Rocky glens, infrequent.

Cystopteris bulbifera Bernh. Winneshiek, Allamakee, Clayton, and Dubuque Cos. Rich soil near base of cliffs, frequent.

C. fragilis Bernh. Winneshiek and Allamakee Cos. Woods, frequent.

Onoclea sensibilis L. Clayton Co. Moist ravines, frequent.

Osmunda claytoniana L. Winneshiek, Allamakee, and Clayton Cos. Low woods, frequent.

OPHIOGLOSSACEÆ.

Botrychium virginianum Swartz. Winneshiek and Allamakee Cos. Rich woods, frequent.

MARCHANTIACEÆ.

Marchanta polymorpha L. Winneshiek, Allamakee, and Dubuque Cos. Wet rocks, frequent.

FLORA OF SOUTHERN IOWA.

T. J. AND M. F. L. FITZPATRICK.

The following notes are based upon collections in our private herbarium. In point of time the period reaches from 1882 to 1897. The counties represented being Decatur, Appanoose, Wapello, Van Buren, Shelby, and Johnson, extended by occasional collections from neighboring counties.

The sedges were determined by R. I. Cratty, the grasses by F. Lamson Scribner, and miscellaneous species by the officers of the Missouri Botanical garden.

To those who wish to obtain a more thorough knowledge of the flora of southern Iowa we submit our results, hoping they are worthy of consideration.

RANUNCULACEÆ,

Clematis virginiana L. Decatur, Appanoose, Des Moines, and Johnson Cos. Fence rows, along streams, frequent.

C. pitcheri T. & G. Decatur, Shelby, and Johnson Cos. Rich woods, frequent.

Anemone patens nuttalliana Gray. Crawford and Shelby Cos. High prairies, common.

A. cylindrica Gray. Decatur and Johnson Cos. Prairies and open woods, frequent.

A. virginiana L. Decatur, Appanoose, Des Moines, and Johnson Cos. Woods, frequent.

A. pennsylvanica L. Des Moines and Johnson Cos.

A. nemorosa L. Johnson Co. Upland woods, common.

Hepatica acutiloba DC. Johnson and Decatur Cos. Upland woods, common.

Anemonella thalictroides Spach. Decatur and Johnson Cos. Upland woods, frequent.

Thalictrum purpurascens L. Decatur, Appanoose, Des Moines Shelby, and Johnson Cos. Rich woods, frequent.

Ranunculus circinatus Sibth. Johnson Co. Ponds frequent.

R. abortivus L. Decatur, Page, Shelby, and Johnson Cos. Low grounds, common.

R. recurvatus Poir. Johnson Co. Woods, frequent.

R. fascicularis Muhl. Johnson Co. Wooded hillsides, common.

R. septentrionalis Poir. Decatur, Shelby, and Johnson Cos. Low grounds, common

R. repens L. Johnson Co. Upland woods, frequent.

R. acris L. Page Co.

Isopyrum biternatum T. & G. Decatur and Johnson Cos. Woods, frequent.

Caltha palustris L. Johnson Co. Wet places, infrequent.

Aquilegia canadensis L. Page, Decatur, Shelby, and Johnson Cos. Woods, common.

Delphinium tricorne Mx. Decatur and Shelby Cos. Rich soil, fields and woods, common.

D. azureum Mx. Page, Decatur, and Shelby Cos. Prairies, common.

D. ajacis L. Johnson Co. Occasionally an escape.

Actæa spicata rubra Ait. Shelby and Johnson Cos. Woods, infrequent.

A. alba Bigel. Decatur and Johnson Cos. Woods, common.

MENISPERMACEÆ.

Menispermum canadense L. Decatur, Shelby, and Johnson Cos. Woods, frequent.

BERBERIDACEÆ.

Caulophyllum thalictroides Mx. Decatur, Shelby, and Johnson Cos. Woods, frequent.

Podophyllum peltatum L. Page, Decatur, Appanoose, and Johnson Cos. Rich upland woods, common.

NYMPHÆACEÆ.

Nymphæa odorata Ait. Johnson Co. Ponds, frequent.

Nuphar advena Ait. Johnson Co. Margins of ponds, frequent.

PAPAVERACEÆ.

Sanguinaria canadensis L. Decatur, Appanoose, Shelby, and Johnson Cos. Rich woods, common.

Argemone mexicana L. Johnson Co. Rarely an escape.

FUMARIACEÆ.

Dicentra cucullaria DC. Decatur, Appanoose, Shelby, Page, and Johnson Cos. Rich woods, common.

Corydalis curvisiliqua Englm. Page and Henry Cos. Probably not frequent. Has been labeled *C. aurea* Willd. and also the variety *occidentalis* Englm.

CRUCIFERÆ.

Dentaria laciniata Muhl. Decatur, Shelby, and Johnson Cos. Rich woods, frequent.

Cardamine rhomboidea DC. Decatur, Shelby, and Johnson Cos. Wet grounds, common.

C. rhomboidea purpurea. Johnson Co.

C. hirsuta L. Decatur and Johnson Cos. Wet soil, frequent.

Arabis dentata T. & G. Henry Co.

A. canadensis L. Decatur Co. Woods, infrequent.

A. confinis Watson. Johnson Co. Woods, common.

Draba caroliniana Walt. Johnson Co. Rocky banks, frequent.

Nasturtium palustre DC. Decatur, Van Buren, Shelby, and Johnson Cos. Wet places, common,

N. obtusum Nutt. Decatur Co. In fields, infrequent.

N. armoracia Fries. Page, Decatur, Shelby, and Johnson Cos. Near dwellings, frequent.

N. sessiliflorum Nutt. Van Buren Co. Frequent along Des Moines river.

Barbarea vulgaris R. Br. Shelby Co. Cultivated fields, infrequent.

Erysimum cheiranthoides L. Johnson Co. Banks, common.

Sisymbrium canescens Nutt. Decatur, Page, and Johnson Cos. Woods, frequent.

S. officinale Scop. Decatur, Shelby, and Johnson Cos. Waste places, common.

Brassica sinapistrum Boiss. Decatur and Johnson Cos. Waste places, infrequent.

B. nigra Koch. Decatur, Appanoose, Johnson, Shelby, and Van Buren Cos. Fields and waste places, common.

B. alba Boiss. Decatur Co. Forms were found with bristly pods. This character, however, varies and the specimens may be the preceding species.

Capsella bursa-pastoris Moench. Page, Decatur, Van Buren, Shelby, and Johnson Cos. Waste grounds, common.

Lepidium virginicum L. Johnson Co. Waste ground, frequent.

L. intermedium Gray. Decatur, Appanoose, and Shelby Cos. Waste places, common.

Raphanus sativus L. Decatur Co. Occasionally an escape.

CAPPARIDACEÆ.

Polanisia trachysperma T. & G. Des Moines and Johnson Cos. Sandy shores, frequent. Usually mistaken for *P. graveolens* Raf.

CISTACEÆ.

Helianthemum canadense Mx. Decatur, Appanoose, Shelby, and Johnson Cos. Prairies, frequent.

Lechea major Mx. Decatur, Appanoose, and Johnson Cos. Borders of woods, frequent.

L. minor L. Johnson Co. Dry soil, frequent.

L. tenuifolia Mx. Van Buren Co. Dry soil, frequent.

VIOLACEÆ.

Viola pedata L. Decatur and Johnson Cos. Open woods, frequent.

V. pedatifida G. Don. Decatur, Shelby, Page, and Johnson Cos. Woods and fields, common, especially southward.

V. palmata L. Decatur and Appanoose Cos. Damp soil, fields and woods, common.

V. palmata cucullata Gray. Decatur, Wapello, Van Buren, Des Moines, Shelby, Page, and Johnson Cos. Fields and woods, common.

V. sagittata Ait. Johnson Co. Woods, frequent locally.

V. pubescens Ait. Decatur, Shelby, and Johnson Cos. Rich woods, frequent.

CARYOPHYLLACEÆ.

Dianthus armeria L. Johnson Co. Upland woods, frequent

Saponaria officinalis L. Decatur, Des Moines, and Johnson Cos. Waste places, frequent.

S. vaccaria L. Johnson Co. Waste places, infrequent.

Silene stellata Ait. Decatur, Appanoose, Van Buren, Des Moines, and Johnson Cos. Rich woods, frequent.

S. nivea Otth. Johnson Co. Along streams, infrequent,

S. antirrhina L. Decatur, Henry, and Johnson Cos. Fields and waste places, frequent.

Lychnis githago Lam. Johnson Co. Waste places, infrequent.

Arenaria lateriflora L. Johnson Co. Low places, frequent.

Stellaria media Smith. Henry Co.

S. longifolia Muhl. Johnson Co. Wet woods, infrequent.

Cerastium nutans Raf. Decatur and Johnson Cos. Wet places, frequent.

PORTULACACEÆ.

Portulaca oleracea L. Decatur, Appanoose, Wapello, Van Buren, Des Moines, and Johnson Cos. Fields and waste places, common.

Claytonia virginica L. Decatur, Van Buren, Des Moines, and Johnson Cos. Rich woods, common.

HYPERICACEÆ.

Hypericum ascyron L. Johnson Co. Prairie, rare.

H. prolificum L. Appanoose, Des Moines, and Jefferson Cos. Waysides, infrequent.

H. mutilum L. Decatur Co. Open woods, common.

H. cistifolium Lam. Appanoose and Johnson Cos. Waste places, infrequent.

H maculatum Walt. Decatur, Appanoose, Van Buren, and Johnson Cos. Open woods, frequeut.

H. canadense L. Decatur and Johnson Cos.

MALVACEÆ.

Malva rotundifolia L. Decatur, Van Buren, and Johnson Cos. Waste places, frequent.

M. sylvestris L. Shelby and Johnson Cos. Waste places, infrequent.

Callirrhoë involucrata Gray. Shelby Co. Open woods, common locality.

Sida spinosa L. Decatur, Van Buren, Henry, and Des Moines Cos. Waste places, frequent.

Abutilon avicennæ Gaertn. Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Fields and waste places, common

Hibiscus militaris Cav. Johnson Co. Borders of ponds, frequent.

H. trionum L. Decatur, Appanoose, Van Buren, and Wapello Cos. Waste ground, frequent.

TILIACEÆ.

Tilia americana L. Decatur, Appanoose, Van Buren, Des Moines, Shelby, and Johnson Cos. Rich soil, frequent.

LINACEÆ.

Linum sulcatum Riddell. Decatur, Appanoose, and Van Buren Cos. Prairies, frequent.

L. usitatissimum L. Decatur, Wayne, Des Moines, and Johnson Cos. Waste places, frequent.

GERANIACEÆ.

Geranium maculatum L. Decatur and Johnson Cos. Rich woods, common.

G. carolinianum L. Johnson Co. Frequent locally.

Oxalis violacea L. Page, Decatur, Des Moines, Shelby, and Johnson Cos. Fields, common.

O corniculata stricta Sav. Page, Decatur, Appanoose, Wapello, Van Buren, Des Moines, and Johnson Cos. Woods and waste places, common.

Impatiens pallida Nutt. Decatur, Appanoose, Des Moines, and Johnson Cos. Wet woods, frequent.

I. fulva Nutt. Decatur, Appanoose, Van Buren, Des Moines, and Johnson Cos. With the preceeding, less frequent.

RUTACEÆ.

Xanthoxylum ame icanum Mill. Decatur, Shelby, and Johnson Cos. Woods, common.

CELASTRACEÆ.

Celastrus scandens L. Decatur and Johnson Cos. Rich woods, frequent.

Euonymus atropurpureus Jacq. Decatur, Van Buren, and Johnson Cos. Woods, frequent.

RHAMNACEÆ.

Rhamnus lanceolata Pursh. Decatur, Des Moines, and Johnson Cos. Borders of fields and woods, frequent.

Ceanothus americanus L. Decatur, Appanoose, Van Buren, Des Moines, Shelby, and Johnson Cos. Open woods and prairies, common in Johnson Co., but infrequent southward.

C. ovatus Desf. Decatur and Shelby Cos. Prairies, common.

VITACEÆ.

Vitis riparia Mx. Decatur, Shelby, and Johnson Cos. Low woods, common.

V. cinerea Englm. Decatur Co. Infrequent.

Ampelopsis quinquefolia Mx. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Woods, frequent.

SAPINDACEÆ.

Æsculus glabra Willd. Decatur, Appanoose, and Van Buren Cos. Rich woods, common.

Acer saccharinum Wang. Decatur, Van Buren, Des Moines, and Johnson Cos. Along rivers, frequent.

A. dasycarpum Ehrh. Decatur, Appanoose, Wapello, Shelby, and Johnson Cos. Along rivers, common.

Negundo aceroides Moench. Page, Decatur, Appanoose, Wapello, Shelby, and Johnson Cos. Low woods, common.

Staphylea trifolia L. Johnson and Decatur Cos. Bluffs, frequent. In Missouri opposite Decatur Co., Iowa.

ANACARDIACEÆ.

Rhus glabra L. Decatur, Wapello, Van Buren, Des Moines, and Johnson Cos. Woods and uplands, common.

R. toxicodendron L. Decatur, Wapello, Van Buren, Des Moines, Shelby, and Johnson Cos. Waysides and woods, frequent.

R. canadensis Marsh. Wapello, Henry, Van Buren, and Jefferson Cos. Rocky woods, frequent Also found near Decatur Co. line, in Missouri.

POLYGALACEÆ.

Polygala senega L. Johnson Co. Woods, common.

P. sanguinea L. Decatur, Appanoose, and Johnson Cos. Fields, common.

P. verticillata ambigua Gray. Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Fields and open woods, frequent.

LEGUMINOSÆ.

Baptisia leucantha T. & G. Decatur, Appanoose, Wapello, Des Moines, Shelby, and Johnson Cos. Fields and open woods, common.

B. leucophæa Nutt. Page, Decatur, Appanoose, Shelby, and Johnson Cos. Open woods, common.

Crotalaria sagittalis L. Johnson Co. Sandy soil, open woods, frequent.

Trifolium pratense L. Page, Decatur, Appanoose, Van Buren, Wapello, Shelby, and Johnson Cos. Cultivated and in waste places, common.

T. reflexum L. Johnson Co. Sandy banks, infrequent

T. repens L. Page, Decatur, Appanoose, Wapello, Van Buren, Shelby, and Johnson Cos. Pastures and waysides, common.

T. hybridum L. Decatur, Shelby, and Johnson Cos. Fields and waste places, frequent.

Melilotus officinalis Willd. Decatur and Johnson Cos. Waste places, infrequent.

M. alba Lam. Decatur, Wapello, Des Moines, and Johnson Cos. Waste places, common.

Medicago sativa L. Decatur Co. Vacant lots, frequent.

Psoralea tenuiflora Pursh. Prairie, common. Decatur Co.

P. argophylla Pursh. Prairies, infrequent. Shelby Co.

P. esculenta Pursh. Prairies, frequent. Shelby Co.

Amorpha canescens Nutt. Decatur, Appanoose, Wapello, Van Buren, Shelby, and Johnson Cos. Dry soil, open woods and waysides, common.

A. fruticosa L. Decatur, Appanoose, Wapello, Shelby, and Johnson Cos. Along water courses, common.

Dalea alopecuroides Willd. Decatur and Johnson Cos. Waysides and waste places, frequent.

Petalostemon violaceus Mx. Decatur, Appanoose and Johnson Cos Prairies, frequent.

P. candidus Mx. Decatur, Appanoose, Wapello, Shelby and Johnson Cos. Prairies, frequent.

Tephrosia virginiana Pers. Johnson Co. Sandy woods, infrequent.

Robinia pseudacacia L. Decatur, Wapello, Des Moines, Shelby, and Johnson Cos. Waste places, frequent.

Astragalus caryocarpus Ker. Decatur and Shelby Cos. Prairies, frequent.

A. canadensis L. Decatur, Appanoose, Van Buren, Des Moines, and Johnson Cos. Rich soil, common.

Glycyrrhiza lepidota Nutt. Decatur Co. Waysides, rare.

Desmodium acuminatum DC. Decatur, Appanoose, and Johnson Cos. Rich woods, common.

D. illinoense Gray. Decatur Co. Prairies, frequent.

D. paniculatum DC. Van Buren and Johnson Cos. Woods, infrequent.

D canadense DC. Decatur, Appanoose, Van Buren, and Johnson Cos. Open woods, frequent.

D. dillenii Darlingt. Johnson Co. Woods, infrequent.

Lespedeza violacea Pers. Decatur, Appanoose, Van Buren and Johnson Cos. Open woods, frequent.

L. capitata Mx. Decatur, Appanoose, and Johnson Cos Prairies and rocky banks, frequent.

Vicia americana Muhl. Shelby Co. Low prairies, frequent.

Lathyrus palustris L. Page and Johnson Cos. Dry woods, infrequent.

Apios tuberosa Moench. Decatur and Johnson Cos. Rich woods and banks, frequent.

Strophostyles angulosa Ell. Decatur, Appanoose, Van Buren, and Johnson Cos. Sandy soil, frequent.

S. pauciflorus Watson. Wapello Co. Sandy ground, frequent.

Amphicarpœa monoica Nutt. Decatur and Johnson Cos. Dry soil, frequent.

A. pitcheri T. & G. Decatur, Van Buren, and Johnson Cos. Woods, common.

Cercis canadensis L. Decatur, Appanoose, Van Buren, Des Moines, Jefferson, and Henry Cos. Wooded bluffs, frequent.

Cassia marylandica L. Ringgold and Appanoose Cos. Rich woods, infrequent. Found in Missouri, opposite Decatur Co.

C. chamæcrista L. Decatur, Appanoose, Wapello, and Johnson Cos. Fields and waysides, common.

Gymnocladus canadensis Lam. Decatur and Johnson Cos. Rich woods, infrequent.

Gleditschia triacanthos L. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Rich woods, common.

ROSACEÆ.

Prunus americana Marsh. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Thickets, common.

P. serotina Ehrh. Decatur, Appanoose, Shelby, and Johnson Cos. Woods, frequent.

P. virginiana L. Decatur, Shelby, Page, and Johnson Cos. Low woods, frequent.

Spiræa salicifolia L; Henry and Johnson Cos. Rocky woods, frequent.

Physocarpus opulifolius Maxim. Decatur and Johnson Cos. Rocky woods, frequent.

Rubus occidentalis L. Page, Decatur, Appanoose, Van Buren, Shelby and Johnson Cos. Woods and fence rows, frequent.

R. villosus Ait. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Woods, common.

P. canadensis L. Decatur and Appanoose Cos. Poor soil, fields, common.

Geum album Gmelin. Decatur, Appanoose, and Johnson Cos. Open woods, frequent.

G. virginianum L. Decatur Co. Low grounds, infrequent.

Fragaria virginiana Mill. Decatur, Shelby, and Johnson Cos. Fields and woods, common.

F. vesca L. Shelby, Page, and Johnson Cos. Woods, infrequent.

Potentilla arguta Pursh. Decatur, Appanoose, Shelby, and Johnson Cos. Prairies, common.

P. norvegica L. Decatur, Shelby, and Johnson Cos. Fields, common.

P. canadensis L. Decatur and Johnson Cos. Waysides and open woods, common.

Agrimonia eupatoria L. Decatur, Appanoose, Van Buren, and Johnson Cos. Woods, common.

A. parviflora Ait. Decatur Co. Low grounds, prairies and woods.

Rosa arkansana Porter. Decatur, Appanoose, Shelby, and Johnson Cos. Prairies and woods, common.

R. humilis Marsh. Johnson Co.

R. blanda Ait. Johnson Co. Woods, frequent.

Pyrus coronaria L. Decatur, Appanoose, Shelby, and Johnson Cos. Tnickets, common.

P. malus L. Decatur and Appanoose Cos. Fields and waste places, not infrequent.

Cratægus coccinea L. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Woods, common.

C. tomentosa L. Page, Decatur, Appanoose, Shelby, and Johnson Cos. Woods, frequent.

C. crus-galli L. Decatur, Wapello, and Johnson Cos. Woods, frequent.

Amelanchier canadensis T. & G. Decatur and Johnson Cos. Bluffs, common.

SAXIFRAGACEÆ.

Saxifraga pennsylvanica L. Johnson Co. Low prairies, common.

Mitella diphylla L. Johnson Co. Woods, common.

Heuchera hispida Pursh. Decatur, Appanoose, and Johnson Cos. Prairies, common.

Ribes cynosbati L. Johnson Co. Woods, common.

R. gracile Mx. Page, Decatur, Appanoose, Shelby, and Johnson Cos. Low grounds, common.

S. floridum L'Her. Johnson Co. Woods, infrequent.

CRASSULACEÆ.

Penthorum sedoides L. Decatur, Appanoose, Van Buren, and Johnson Cos. Wet ground, common.

Sedum telephium L. Decatur and Johnson Cos. Occasionally an escape.

HALORAGEÆ.

Myriophyllum scabratum Mx. Appanoose Co. In shallow water, common.

LYTHRACEÆ.

Lythrum alatum Pursh. Decatur, Appanoose, and Johnson Cos. Fields and low places, common.

Rotala ramosior Koehne. Henry Co.

Ammannia coccinea Rottb. Johnson Co. Sandy shores, infrequent.

ONAGRACEÆ.

Ludwigia alternifolia L. Decatur and Johnson Cos. Wet ground, infrequent.

L. polycarpa Short & Peter. Decatur and Appanoose Cos. Margins of ponds, common.

L. palustris Ell. Johnson Co. In water or wet places, infrequent.

Epilobium angustifolium L. Shelby Co. Woods, infrequent.

E. coloratum Muhl. Decatur, Van Buren, and Johnson Cos. Wet ground along rivers, frequent.

Gaura coccinea Nutt. Decatur, Appanoose, and Johnson Cos. Fields and waste places, common.

Oenothera biennis L. Van Buren and Johnson Cos. Waste ground, frequent.

Oe. rhombipetala Nutt. Decatur, Van Buren, Des Moines, and Johnson Cos. Fields and waste places, common.

Oe. serrulata Nutt. Shelby Co. Prairies, frequent.

Circæa lutetiana L. Decatur, Appanoose, Henry, and Johnson Cos. Woods, common.

CUCURBITACEÆ.

Sicyos angulata L. Des Moines Co. Waste places, frequent.

Echinocystis lobata T. & G. Decatur, Des Moines, Shelby, and Johnson Cos. Low woods, common.

FICOIDEÆ.

Mollugo verticillata L. Decatur and Johnson Cos. Sandy shores, frequent.

UMBELLIFERÆ.

Daucus carota L. Decatur and Appanoose Cos. Fields infrequent.

Tiedemannia rigida Coult. & Rose. Decatur Co. Wet sloughs, frequent; often on high prairies.

Heracleum lanatum Mx. Decatur and Shelby Cos. Rich woods, common.

Cicuta maculata L. Decatur, Appanoose, Van Buren, and Johnson Cos. Wet places, common.

Thaspium barbinode Nutt. Des Moines and Johnson Cos. Woods, frequent.

Pimpiella integerrima Benth & Hook. Decatur, Appanoose, and Johnson Cos. Woods, frequent.

Polytænia nuttallii DC. Decatur and Appanoose Cos. Dry woods, infrequent.

Cryptotænia canadensis DC. Decatur, Appanoose, Shelby, and Johnson Cos. Rich woods, common.

Sium cicutæfolium Gmelin. Decatur and Des Moines Cos. Shallow ponds, frequent.

Fœniculum officinale All. Johnson Co. Occasionally an escape.

Zizia aurea Koch. Decatur and Shelby Cos. Low grounds, common.

Chærophyllum procumbens Crantz. Decatur, Henry, and Johnson Cos. Low woods, frequent.

Osmorrhiza longistylis DC. Decatur, Shelby, and Johnson Cos. Rich woods, frequent.

O. brevistylis DC. Decatur, Appanoose, Shelby, and Johnson Cos. Rich woods, frequent.

Eryngium yuccæfolium Mx. Decatur, Appanoose, Shelby, and Johnson Cos. Prairies, common.

Sanicula marylandica L. Decatur, Shelby, and Johnson Cos. Woods, common.

S. marylandica canadensis Torr. Appanoose and Johnson Cos. Woods, frequent.

ARALIACEÆ.

Aralia racemosa L. Van Buren, Des Moines, and Johnson Cos. Woods, frequent.

A. nudicaulis L. Johnson Co. Woods, frequent.

A. quinquefolia Decs. & Planch. Johnson Co. Woods, frequent. Seems to prefer the north hill sides.

CORNACEÆ.

Cornus paniculata L'Her. Decatur, Appanoose, Wapello, Van Buren, Des Moines, Shelby, and Johnson Cos. Low grounds, common.

C. sericea L. Decatur, Appanoose, Shelby, and Johnson Cos. Low woods, frequent

CAPRIFOLIACEÆ.

Sambucus canadensis L. Decatur, Appanoose, Van Buren, Des Moines, Shelby, and Johnson Cos. Rich woods and fields, common.

Viburnum lentago L. Shelby, Appanoose, and Johnson Cos. Woods, frequent.

Triosteum perfoliatum L. Decatur, Appanoose, Shelby and Johnson Cos. Open woods, common.

Symphoricarpus vulgaris Mx. Decatur, Appanoose, Wapello, Van Buren, and Shelby Cos. Prairies and woods, common.

S. occidentalis Hook. Shelby Co. Open woods, frequent.

Lonicera sullivantii Gray. Johnson Co. Woods, frequent.

RUBIACEÆ.

Houstonia minima Beck. Johnson Co

H. angustifolia Mx. Shelby Co. Sandy prairie soil, frequent.

Cephalanthus occidentalis L. Decatur, Appanoose, and Johnson Cos. Wet low woods, frequent.

Galium aparine L. Decatur, Shelby, and Johnson Cos. Woods, common.

G. trifidum Decatur Co. Woods, frequent.

G. trifidum latifolium Torr. Johnson Co.

G. concinnum T. & G. Decatur, Appanoose, and Johnson Cos. Woods, common.

G. triflorum Mx. Decatur and Johnson Cos. Rich woods, common.

G. circæzans Mx. Decatur and Van Buren Cos. Woods, frequent.

COMPOSITÆ.

Vernonia fasciculata Mx. Decatur, Wapello, Van Buren, and Johnson Cos. Low grounds, common.

V. noveboracensis latifolia Gray. Decatur, Appanoose, and Van Buren Cos. Borders and open woods, common.

Eupatorium purpureum L. Decatur, Appanoose, and Johnson Cos. Woods and low pastures, common.

E ageratoides L. Decatur, Appanoose, Van Buren, and Johnson Cos. Woods, common.

E. perfoliatum L. Decatur, Wapello, Van Buren, and Johnson Cos. Open woods, common.

E. altissimum L. Decatur and Johnson Cos. Upland woods, or prairies, infrequent.

Kuhnia eupatorioides L. Decatur and Johnson Cos. Dry soil,

Liatris scariosa Willd. Decatur and Johnson Cos. Prairies, common.

L pycnostachya Mx. Decatur, Appanoose, and Johnson Cos. Prairies, common.

L squarrosa Willd. Decatur and Wapello Cos. Prairies, common.

Grindelia squarrosa Dunal. Henry Co. Waste places, infrequent.

Solidago rigida L. Decatur and Johnson Cos. Prairies, common.

S. ulmifolia Muhl. Decatur and Johnson Cos. Woods, frequent.

S. latifolia L. Decatur and Johnson Cos. Woods, frequent.

S. speciosa Nutt. Decatur and Johnson Cos. Prairies, common.

S. serotina Ait. Decatur, Henry, and Johnson Cos. Borders of woods, frequent.

S. canadensis L. Decatur, Henry, and Johnson Cos. Open woods and borders of fields, common.

S. nemoralis Ait. Decatur and Johnson Cos. Prairies, common.

S. lanceolata L. Decatur, Henry, and Johnson Cos. Sandy soil, common.

Boltonia asteroides L'Her. Decatur and Johnson Cos. Wet ground, frequent.

Aster sericeus Vent. Decatur and Johnson Cos. Prairies, common.

A. shortii Hook. Johnson Co. Woods, infrequent.

A. oblongifolius Nutt. Johnson Co. Dry soil, infrequent.

A multiflorus Ait. Decatur, Henry, and Johnson Cos. Prairies and waysides, common.

A. novæ-angliæ L. Decatur and Johnson Cos. Woods, frequent.

A. prenanthoides Muhl. Johnson Co. Woods, frequent.

A. salicifolius Ait. Decatur, Henry, and Johnson Cos. Copses, open places, frequent.

A azureus Lindl. Decatur, Appanoose, and Johnson Cos. Woods and prairies, common.

A cordifolius L. Decatur and Johnson Cos. Woods, infrequent.

A. sagittifolius Willd. Johnson and Decatur Cos. Woods frequent.

A. lævis L. Decatur Co. Woods, open places, common.

A. diffusus Ait. Decatur Co. Low woods, common.

Erigeron bellidifolius Muhl. Johnson Co. Woods, infrequent.

E strigosus Muhl. Shelby and Johnson Cos. Fields and waste places, common.

E. philadelphicus L. Decatur, Shelby, and Johnson Cos. Rich woods, frequent.

E. divaricatus Mx. Decatur, Appanoose, and Johnson Cos. Dry soil, pastures, common.

E. canadense L. Decatur and Appanoose Cos. Waste places, common.

E. annuus Pers. Appanoose, Shelby, and Johnson Cos. Waste places, common.

Antennaria plantaginifolia Hook. Decatur, Appanoose, Shelby, Page, and Johnson Cos. Meadows and upland woods, common.

Anaphalis margaritacea Benth. & Hook. Decatur and Johnson Cos. Dry woods, frequent.

Inula helenium L. Johnson Co. Open woods, frequent locally.

Polymnia canadensis L. Des Moines Co. Along cliffs, frequent.

Silphium perfoliatum L. Decatur, Van Buren, Des Moines, Shelby, and Johnson Cos. Low grounds, frequent.

S. integrifolium Mx. Decatur, Appanoose, Van Buren, and Johnson Cos. Prairies and open woods, frequent.

S. laciniatum L Decatur, Appanoose, and Johnson Cos. Prairies, common.

Parthenium integrifolium L. Decatur, Appanoose, and Johnson Cos. Prairies, common.

Ambrosia artemisæfolia L. Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Waste places, very common.

A. trifida L. Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Waste ground, common.

A. trifida integrifolia T. & G. Decatur and Johnson Cos. Waste places, frequent.

A. psilostachya DC. Decatur and Johnson Cos. Waste places, frequent.

Xanthium canadense Mill. Decatur, Appanoose, Wapello, and Johnson Cos. Fields and waste places, common.

Eclipta alba Hassk. Johnson Co. Along river banks, infrequent.

Heliopsis scabra Dunal. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Prairies, common.

Echinacea purpurea Moench. Decatur and Appanoose Cos. Woods, infrequent.

E. angustifolia DC. Decatur, Shelby, and Johnson Cos. Prairies, frequent.

Rudbeckia triloba L. Decatur, Wapello, Van Buren, and Johnson Cos. Open woods, common.

R. hirta L. Decatur, Appanoose, Van Buren, and Johnson Cos. Open woods and prairies, frequent.

R. laciniata L. Decatur and Johnson Cos. Low woods, common.

R. subtomentosa Pursh. Decatur Co. Prairies, infrequent.

Lepachys pinnata T. & G. Decatur, Appanoose, and Johnson Cos. Prairies, common.

Helianthus annuus L. Decatur, Appanoose, Van Buren, Des Moines, and Johnson Cos. Waste places, frequent.

H. rigidus Desf. Decatur and Johnson Cos. Prairies, frequent.

H. occidentalis Rid. Johnson Co. Prairies, frequent.

H. grosse-serratus Mart. Decatur, Appanoose, and Johnson Cos. Low grounds, common.

H. hirsutus Raf. Decatur and Van Buren Cos. Prairies, frequent.

H. strumosus L. Johnson Co. Borders and low woods, frequent.

H. tuberosus L. Decatur, Van Buren, and Henry Cos. Low woods and prairies, frequent.

Actinomeris squarrosa Nutt. Decatur, Appanoose, and Johnson Cos. Low woods, frequent.

Coreopsis palmata Nutt. Decatur, Shelby, and Johnson Cos. Prairies, common.

C. tripteris L. Decatur and Johnson Cos. Prairies and open woods, frequent.

C. involucrata Nutt. Decatur and Johnson Cos. Wet grounds, common.

Bidens frondosa L. Decatur, Appanoose, and Johnson Cos. Low grounds, common.

B. connata Muhl. Decatur and Johnson Cos. Low grounds, frequent.

B. cernua L. Decatur and Johnson Cos. Wet grounds, low woods, frequent.

B. chrysanthemoides Mx. Decatur and Johnson Cos. Low waste places, frequent.

Helenium autumnale L. Decatur, Appanoose, Des Moines, and Johnson Cos. River banks, moist places, frequent.

Dysodia chrysanthemoides Lag. Decatur, Appanoose, Wapello, Van Buren, Shelby, and Johnson Cos. Waste places, common.

Anthemis cotula DC. Decatur, Appanoose, Wapello, Van Buren, Des Moines, Shelby, and Johnson Cos. Waste places, common.

Achillea millefolium L. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Fields and waste places, common.

Chrysanthemum leucanthemum L. Decatur and Johnson Cos. Waste places, infrequent.

Tanacetum vulgare L. Decatur and Johnson Cos Waste places near dwellings, infrequent.

Artemisia biennis Willd. Decatur, Appanoose, Wapello, and Johnson Cos. Waste places, frequent.

A. ludoviciana Nutt. Decatur and Johnson Cos. Waysides and fields, common.

Senecio aureus L. Johnson Co. Rich woods, infrequent.

S. aureus balsamitæ T. & G. Page, Decatur, Shelby, and Johnson Cos. Rich woods, common.

Cacalia reniformis Muhl. Johnson Co. Woods, infrequent.

C atriplicifolia L. Decatur, Van Buren, and Johnson Cos. Rich woods and prairies, frequent.

C. tuberosa Nutt. Decatur, Appanoose, and Shelby Cos. Moist prairies, frequent.

Erechtites hieracifolia Raf. Decatur and Johnson Cos. Open woods, frequent.

Arctium lappa L. Decatur, Appanoose, Van Buren, Des Moines, and Johnson Cos. Waste places, frequent.

Cnicus lanceolatus Hoffm. Decatur, Appanoose, Van Buren, and Johnson Cos. Fields and waste places, common.

C. altissimus Willd. Decatur and Johnson Cos. Waste places, frequent.

C. altissimus discolor Gray. Johnson Co. Waste places, frequent.

C. arvensis Hoffm Decatur and Johnson Cos. Fields and waste places, infrequent.

Krigia amplexicaulis Nutt. Johnson Co. Woods, frequent.

Hieracium canadense Mx. Johnson Co. Open woods, infrequent.

H. scabrum Mx. Decatur and Johnson Cos. Dry woods, frequent.

H. longipilum Torr. Decatur Co. Sandy prairie, infrequent.

Prenanthes aspera Mx. Decatur Co. Open woods, frequent.

P. crepidinea Mx. Johnson Co. We have one specimen.

P. alba Johnson Co. Woods, frequent.

Lygodesmia juncea Don. Shelby Co. Fields and waste places, common.

Troximon cuspidatum Pursh. Shelby and Johnson Cos. High prairies, infrequent.

Taraxacum officinale Weber Shelby, Page, Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Pastures and waysides, common.

Lactuca scariola L. Van Buren, Henry, and Johnson Cos. Waste places, frequent.

L. canadensis L. Decatur and Johnson Cos. Waste ground, frequent.

L. acuminata Gray. Decatur, Van Buren, Des Moines, and Johnson Cos.

Sonchus asper Vill. Decatur and Johnson Cos. Waste grounds, frequent.

S. oleraceus Johnson Co Waste grounds, frequent.

LOBELIACEÆ.

Lobelia cardinalis L. Appanoose and Johnson Cos. Wet low woods, frequent.

L. syphilitica L. Decatur and Johnson Cos. Moist soil, common.

L. spicata Lam. Decatur, Van Buren, and Johnson Cos. Fields, common.

L. inflata L. Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Open woods, frequent.

CAMPANULACEÆ.

Specularia perfoliata A. DC. Decatur and Johnson Cos. Fields and woods, frequent.

Campanula americana L. Decatur, Appanoose, Van Buren, Des Moines, and Johnson Cos. Waste places, fields, and woods, frequent.

ERICACEÆ.

Pyrola elliptica Nutt. Johnson Co. Upland woods, frequent.

Monotropa uniflora L. Johnson Co. Upland woods, common.

PRIMULACEÆ.

Dodecatheon media L. Johnson Co. Open woods, frequent.

Androscae occidentalis Pursh. Johnson Co. Rocky shores, frequent

Steironema ciliatum Raf. Decatur. Des Moines, and Johnson Cos. Rich open woods, common.

S. lanceolatum Gray. Johnson Co. Rich soil, infrequent.

OLEACEÆ.

Fraxinus viridis Mx. Decatur, Shelby, and Johnson Cos. Woods, frequent.

F. americana L. Johnson Co. Woods, infrequent.

APOCYNACEÆ.

Apocynum androsæmifolum L. Decatur, Appanoose, Des Moines, and Johnson Cos. Fields and borders of woods, frequent.

A. cannabinum L. Decatur, Appanoose, Des Moines, Shelby, and Johnson Cos. Fields and waste places, frequent.

ASCLEPIADACEÆ.

Asclepias tuberosa L. Decatur, Appanoose, Des Moines, Shelby, and Johnson Cos. Prairies and fields, common.

A incarnata L. Decatur and Johnson Cos. Wet grounds, common.

A. purpurascens L. Decatur and Johnson Cos. Infrequent.

A cornuti DC. Decatur, Appanoose, Wapello, and Johnson Cos. Fields, common.

A. sullivantii Englm. Shelby Co. Infrequent.

A obtusifolia Mx. Shelby and Johnson Cos. Infrequent.

A. meadii Torr. Decatur Co. Waysides, infrequent.

A. phytolaccoides Pursh Johnson Cos. Open woods, infrequent.

A. verticillata L. Decatur, Des Moines, and Johnson Cos Open woods and fields, common.

Acerates longifolia Ell. Decatur, Appanoose, and Johnson Cos. Prairies, common

A. viridiflora Ell. Decatur Co. Prairies, common.

GENTIANACEÆ.

Gentiana crinita Froel. Johnson Co. Springy places, frequent locally.

G. quinqueflora occidentalis Gray, Johnson Co. Open woods, infrequent.

G. puberula Mx. Decatur, Jefferson, and Johnson Cos. Prairies, infrequent.

G. andrewsii Griseb. Johnson Co. Low grounds, infrequent.

G. alba Muhl. Decatur Co. Open woods, infrequent.

POLEMONIACEÆ.

Phlox paniculata L. Johnson Co. Occasionally an escape near dwellings.

P pilosa L. Decatur, Shelby, and Johnson Cos. Open woods and prairies, frequent.

P. divaricata L, Decatur, Des Moines, Shelby, and Johnson Cos. Rich woods, common.

P. subulata L Page Co. Infrequent.

Gilia linerais Gray. Decatur Co. Prairie, frequent.

Polemonium reptans L. Decatur and Johnson Cos. Rich woods, common.

HYDROPHYLLACEÆ.

Hydrophyllum virginicum L. Decatur, Shelby, and Johnson Cos. Low woods, common.

H. appendiculatum Mx. Des Moines Co. Wooded ravines, frequent.

Ellisia nyctelea L. Decatur, Shelby, and Johnson Cos. Low grounds, common.

BORRAGINACEÆ.

Cynoglossum officinale L. Des Moines Co. Waste places, infrequent.

Echinospermum virginicum Lehm. Decatur and Johnson Cos.

E. lappula Lehm. Wapello and Johnson Cos. Roadsides and rocky woods, frequent.

Mertensia virginicum DC. Page, Van Buren, Des Moines, and Johnson Cos. Damp woods, frequent.

Myosotis verna Nutt. Johnson Co.

Lithospermum latifolium Mx. Shelby Co Woods, infrequent.

L. hirtum Lehm. Johnson Co. Sandy soil, frequent.

L. canescens Lehm. Page, Decatur, Shelby, and Johnson Cos. Prairies, common.

L. angustifolium Mx. Shelby Co. Prairies, common.

Onosmodium carolinianum DC. Shelby Co. Upland pastures, common. Johnson Co. Sandy soil along the Cedar river, frequent.

CONVOLVULACEÆ.

Ipomœa pandurata Meyer. Decatur, Van Buren, Henry, and Des Moines Cos.

I. purpurea Lam. Decatur Co. Cultivated fields and waste places, infrequent.

I. hederacea Jacq. Johnson Co. Waste places, infrequent.

Convolvulus sepium L. Decatur, Des Moines, Shelby, and Johnson Cos. Borders and upland woods, frequent.

C. spithamæus L. Johnson Co. One specimen collected.

C. arvensis L. Henry and Johnson Cos. Waste places, infrequent.

Cuscuta glomerata Choisy. Decatur and Johnson Cos. Low grounds, frequent.

C. tenuiflora Englm. Decatur and Johnson Cos. Along streams, frequent.

C. inflexa Englm. Decatur Co. Open woods, infrequent.

SOLANACEÆ.

Solanum nigrum L. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Low grounds, frequent.

S. carolinense L. Decatur, Des Moines, Henry, and Johnson Cos. Waste places, frequent locally.

S. rostratum Dunal. Decatur, Henry, and Johnson Cos. Waste places, infrequent.

S. tuberosum L. Decatur Co. Occasionally an escape, but not persistent.

Physalis pubescens L. Decatur Co. Fields and woods, frequent.

P. virginiana Mill. Decatur, Van Buren, and Johnson Cos.

P. lanceolata Mx. Decatur and Shelby Cos. Fields and waysides, frequent.

Lycium vulgare Dunal. Appanoose Co. A few places known where this species has been observed for a generation. Decatur Co. Along the streets, rare.

Datura stramonium L. Decatur, Appanoose, Wapello, and Johnson Cos. Waste places, common.

D. tatula L. Decatur, Appanoose, Wapello, Van Buren, Des Moines, and Johnson Cos. Waste places, common.

SCROPHULARIACEÆ.

Verbascum thapsus L. Decatur, Appanoose, Wapello, Van Buren, Des Moines, and Johnson Cos. Old pastures and waste places, common.

V. blattaria L. Van Buren and Johnson Cos. Waste places, frequent.

Linaria vulgaris Mill. Decatur, Appanoose, Wapello, Van Buren, Des Moines, and Johnson Cos. Waste places, frequent.

Scrophularia nodosa marylandica Gray. Decatur, Van Buren, Des Moines, and Johnson Cos. Woods, frequent.

Collinsia verna Nutt. Jefferson Co. Frequent, locally.

Chelone glabra L. Johnson Co. Wet places, infrequent.

C. obliqua L. Jefferson Co. Infrequent.

Pentstemon pubescens Sol. Appanoose Co. Open woods, frequent.

P. lævigatus digitalis Gray. Appanoose and Johnson Cos. Open woods, frequent.

Mimulus ringens L. Decatur and Johnson Cos. Wet grounds, frequent.

M. jamesii Torr. Des Moines Co. Calcareous springs, frequent.

M. alatus Ait. Appanoose Co. Infrequent.

Gratiola virginiana L. Decatur and Appanoose Cos. Open woods, frequent.

Ilysanthes riparia Raf. Decatur, Van Buren, and Johnson Cos. Along waterways, common.

Veronica virginica L. Decatur, Appanoose, Van Buren, and Johnson Cos. Woods and prairies, common.

V. anagallis L. Appanoose Co. Wet places, frequent.

V. peregrina L. Decatur, Shelby, and Johnson Cos. Wet soil, common.

V. arvensis L. Henry Co.

Seymeria macrophylla Nutt. Van Buren, Des Moines, and Johnson Cos. Open woods, frequent.

Gerardia grandiflora Benth. Appanoose, Van Buren, and Jefferson Cos. Open woods, frequent.

G. auriculata Mx. Decatur and Johnson Cos. Low prairies and open woods, frequent.

G. aspera Dougl. Decatur Co. Low prairies, infrequent.

G. tenuifolia Vahl. Decatur, Washington, and Johnson Cos. Prairies and woods, common.

Castilleia coccinea Spreng. Appanoose and Johnson Cos. Open woods, frequent.

C. sessiliflora Pursh. Shelby Co. Prairies, frequent.

Pedicularis lanceolata Mx. Johnson Co. Springy ground, frequent, locally.

P. canadensis L. Decatur, Shelby, and Johnson Cos. Open woods and prairies, common.

OROBANCHACEÆ.

Aphyllon uniflorum Gray. Decatur, Jefferson, and Johnson Cos. Woods and prairies, infrequent.

BIGNONIACEÆ.

Catalpa speciosa Wardner. Decatur, Des Moines, Shelby, and Johnson Cos. Frequently cultivated, rarely spontaneous.

ACANTHACEÆ.

Ruellia ciliosa Pursh. Decatur, Appanoose, Wapello, Van Buren and Johnson Cos. Open woods, borders, waysides, common.

R. strepens L. Decatur Co. Shaded ravines, frequent locally.

VERBENACEÆ.

Verbena urticæfolia L. Decatur, Appanoose, Wapello, Des Moines, and Johnson Cos. Fields and waste places, common.

V. angustifolia Mx. Henry and Johnson Cos. Sandy soil, frequent.

V. hastata L. Decatur, Appanoose, Wapello, Des Moines, Shelby, and Johnson Cos. Fields and waste places, common.

V. stricta Vent. Decatur, Appanoose, Van Buren, Des Moines, Shelby, and Johnson Cos. Fields and upland woods, common.

V. bracteosa Mx. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Waste places, frequent.

Lippia lanceolata Mx. Wapello, Van Buren, and Johnson Cos. Wet grounds, frequent.

Phryma leptostachya L. Decatur, Appanoose, and Johnson Cos. Rich woods, frequent.

LABIATÆ.

Isanthus cœruleus Mx. Johnson Co. Open woods, frequent.

Teucrium canadense L. Decatur, Appanoose, Van Buren, and Johnson Cos. Low grounds, frequent.

Mentha canadensis L. Decatur and Johnson Cos. Low grounds, common.

Lycopus virginicus L. Decatur Co. Low grounds, frequent.

L. rubellus Moench. Decatur Co. Low grounds, infrequent.

L. sinuatus Ell. Decatur, Van Buren, and Johnson Cos. Low grounds, common.

Pycnanthemum lanceolatum Pursh. Decatur, Appanoose, Wapello, and Johnson Cos. Open woods and prairies, frequent.

P. linefolium Pursh. Decatur, Appanoose, and Johnson Cos. Open woods and prairies, frequent.

Hedeoma pulegioides Pers. Decatur, Van Buren, and Johnson Cos. Open woods, common.

H. hipsida Pursh. Johnson Co. Dry soil, common.

Monarda fistulosa L. Decatur, Appanoose, Wapello, Jefferson, and Johnson Cos. Prairies and open woods, common.

M. punctata L. Johnson Co. Sandy soil, infrequent.

Blephilia hirsuta Benth. Johnson Co. Rich woods, frequent.

Lophanthus scrophulariæfolius Benth. Decatur, Appanoose, and Johnson Cos. Open woods, frequent.

L. nepetoides Benth. Decatur, Van Buren, Des Moines, and Johnson Cos. Open woods, frequent.

Salvia lanceolata Willd. Shelby Co. Dry soil, frequent.

Nepeta cataria L. Decatur, Appanoose, Des Moines, and Johnson Cos. Waste places, common.

N glechoma Benth. Page, Decatur, Des Moines, and Johnson Cos. Waste grounds near dwellings, frequent.

Scutellaria lateriflora L. Decatur, Appanoose, and Johnson Cos. Woods, frequent.

S. versicolor Nutt. Van Buren, Des Moines, and Johnson Cos. Woods, frequent.

S. parvula Mx. Decatur, Appanoose, Wapello, Shelby, and Johnson Cos. Prairies, frequent.

Brunella vulgaris L. Decatur, Appanoose, Van Buren, Des Moines, and Johnson Cos. Open woods and waste places, common.

Physostegia virginia Benth. Johnson Co. Low woods, frequent.

Leonurus cardiaca L. Appanoose, Des Moines, and Johnson Cos. Waste places, frequent.

Stachys palustris L. Shelby and Johnson Cos. Low places, frequent.

S. aspera Mx. Decatur, Appanoose, and Johnson Cos. Low places, frequent.

PLANTAGINACEÆ.

Plantago rugellii Dec. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Waste places and low woods, common.

P. lanceolata L. Decatur Co. Waste places, becoming frequent.

P. patagonica aristata Gray. Decatur, Appanoose, and Van Buren Cos. Waste places, common.

NYCTAGINACEÆ.

Oxybaphus nyctagineus Sweet. Decatur, Wapello, Van Buren, Shelby, and Johnson Cos. Along waterways, frequent.

O. hirsutus Sweet. Shelby Co. Prairie roadsides, frequent.

O. angustifolius Sweet. Decatur Co. Prairies, infrequennt.

ILLECEBRACEÆ.

Anychia dichotoma Mx. Johnson Co. Woods, frequent.

A. capillacea DC. Decatur and Johnson Cos. Woods, frequent.

AMARANTACEÆ.

Amarantus retroflexus L. Decatur, Van Buren, and Johnson Cos.

A. albus L. Decatur Co.

A. blitoides Watson. Decatur and Johnson Cos. Waste places, frequent.

A. chlorostachys Willd. Johnson Co.

A. paniculatus L. Johnson Co.

Acnida tuberculata Moq. Decatur and Johnson Cos. Waste places, frequent.

Chenopodium album L. Decatur, Van Buren, and Johnson Cos. Waste places, common.

C. hybridum L. Decatur Co. Fields, infrequent.

POLYGONACEÆ.

Rumex britannica L. Decatur Co.

R. altissimus Wood. Decatur and Johnson Cos. Rich soil, frequent.

R. verticillata L. Appanoose and Johnson Cos. Rich soil, frequent.

R. obtusifolius L. Page and Shelby Cos. Rich soil, frequent.

R. crispus L. Shelby and Johnson Cos. Waste places, common.

R. acetosella L. Decatur, Shelby, and Johnson Cos. Waste places, common.

Polygonum orientale L. Johnson Co. Waste places, infrequent.

P. pennsylvanicum L. Decatur and Johnson Cos. Wet soil, common.

P. lapathifolium incarnatum Watson. Appanoose Co. Wet soil, frequent.

P. hydropiper L. Decatur and Johnson Cos. Wet soil, frequent.

P. hydropiperoides Mx. Johnson Co. Wet soil, frequent.

P. hartwrightii Gray. Henry Co.

P. virginianum L. Decatur and Johnson Cos. Low woods, frequent.

P. aviculare L. Decatur, Appanoose, and Johnson Cos. Waste places, common.

P. erectum L. Decatur Co. Waste places, common.

P. ramosissimum Mx. Decatur, Des Moines, and Johnson Cos. Sandy soil, common,

P. sagittatum L. Johnson Co. Wet soil, common.

P. convolvulus L. Shelby and Johnson Cos. Fields and waste places, common.

P. dumetorium scandens Gray. Decatur Co.

P. cuspidatum Sieb & Jucc. Johnson Co. Rarely an escape into waste places.

Fagopyrum esculentum Moench. Decatur, Appanoose, Des Moines, Shelby, and Johnson Cos. Fields and waste places, infrequent.

ARISTOLOCHIACEÆ.

Asarum canadense D. Decatur, Appanoose, Des Moines, and Johnson Cos. Wooded river bluffs, frequent.

THYMELÆACEÆ.

Dirca palustris L. Johnson Co. Open woods, frequent locally.

SANTALIACEÆ.

Commandra umbellata Nutt. Decatur, Des Moines, and Johnson Cos. Sandy soil in woods, frequent.

EUPHORBIACEÆ.

Euphorbia maculata L. Decatur, Wapello, and Johnson Cos. Waste places, common.

E. preslii Guss. Decatur, Van Buren, and Johnson Cos. Waste places, frequent.

D. marginata Pursh. Decatur, Van Buren, and Johnson Cos. Waste places, infrequent.

E. corollata L. Decatur, Appanoose, Wapello, Van Buren, Des Moines, Shelby, and Johnson Cos. Fields, prairies, and open woods, common.

E. heterophylla L. Wapello, Van Buren, and Johnson Cos. Rocky wooded banks, frequent.

E. dentata Mx. Des Moines Co. Waste places near railroad, frequent.

E. obtusata Pursh. Johnson Co. Sandy soil in woods, infrequent.

E. cyparissias L. Shelby, Henry, and Johnson Cos. Waste places, infrequent.

Croton glandulosus L. Des Moines Co. Waste places near railroad, frequent.

Acalypha virginica L. Decatur, Van Buren, and Johnson Cos. Fields and waste places, common.

URTICACEÆ.

Ulmus fulva Mx. Decatur, Appanoose, and Johnson Cos. Rich woods, frequent.

U. americana L. Page, Decatur, Appanoose, Wapello, Van Buren, Des Moines, Shelby, and Johnson Cos. Low woods, common.

Celtis occidentalis L. Decatur, Appanoose, and Johnson Cos. Low woods, frequent.

Cannabis sativa L. Decatur, Van Buren, Des Moines, Shelby, and Johnson Cos. Waste places, frequent.

Humulus lupulus L. Decatur, Appanoose, and Johnson Cos. Waysides and thickets, common.

Maclura aurantiaca Nutt. Decatur, Appanoose, Shelby, and Johnson Cos. Formerly much used for hedge fences, sometimes spontaneous.

Morus rubra L. Decatur, Appanoose, Des Moines, and Johnson Cos. Rich woods, frequent.

Urtica gracilis Ait. Decatur Co. Alluvial soil, infrequent.

Pilea pumila Gray. Decatur, Des Moines, and Johnson Cos. Rich woods, common.

Laportea canadensis Gaud. Decatur, Appanoose, and Johnson Cos. Moist woods, common.

Bœhmeria cylindrica Willd. Johnson Co. Moist woods, frequent.

Parietaria pennsylvanica Muhl. Shelby and Johnson Cos. Low woods, frequent.

PLANTANACEÆ.

Plantanus occidentalis L. Decatur, Van Buren, Lee, Des Moines, and Johnson Cos. A frequent tree along the larger rivers.

JUGLANDACEÆ.

Juglans cinerea L. Johnson Co. Rich woods, frequent.

J. nigra L. Decatur, Appanoose, Van Buren, and Johnson Cos. Rich woods, frequent.

Carya alba Nutt. Decatur, Appanoose, Wapello, Van Buren, Shelby, and Johnson Cos. Upland woods, common once but disappearing.

C. sulcata Nutt. Decatur, Appanoose, and Van Buren Cos. Along rivers, once common, yet frequent.

C. amara Nutt. Decatur, Appanoose, Shelby, and Johnson Cos. Rich woods, common.

CUPULIPERÆ.

Betula nigra L. Appanoose and Johnson Cos. Woods, frequent.

Corylus americana Walt. Decatur, Appanoose, Wapello, Van Buren, Shelby, and Johnson Cos. Thickets, common.

Ostrya virginica Willd. Decatur, Henry, and Johnson Cos. Woods, frequent.

Carpinus caroliniana Walter. Decatur, Appanoose, Wapello, Van Buren, Des Moines, and Johnson Cos. Woods, frequent.

Quercus alba L. Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Upland woods, common.

Q. stellata Wang. Appanoose Co. One small grove known.

Q. macrocarpa Mx. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Woods, common. This is a large tree along the rivers, but a shrub on the prairies.

Q. bicolor Willd. Decatur and Appanoose Cos. Along rivers, frequent.

Q muhlenbergii Englm. Decatur, Appanoose, Van Buren, Henry and Johnson Cos. Woods along streams, frequent.

Q. prinoides Willd. Decatur and Appanoose Cos. Prairies and upland woods, common. Similar to preceding, but of diminutive size, usually one or two feet high.

Q. rubra L. Decatur, Appanoose, Wapello, Van Buren, and Johnson Cos. Woods, frequent.

Q. coccinea Wang. Decatur, Appanoose, and Johnson Cos. Upland woods, common.

Q palustris Du Roi. Decatur and Appanoose Cos. Low woods, frequent.

Q. imbricaria Mx. Decatur, Appanoose, Wapello, and Washington Cos. Woods, common.

Q. nigra L. Decatur Co. Dry upland woods, frequent.

SALICACEÆ.

Salix longifolia Muhl. Shelby and Page Cos. Frequent.

S. discolor Muhl. Shelby and Johnson Cos. Low grounds, common.

S. humilis Marsh. Decatur, Shelby, and Johnson Cos. Prairies, frequent.

Populus tremuloides Mx. Decatur, Appanoose, Shelby, and Johnson Cos. Upland woods, common.

P. grandidentata Mx. Johnson Co. Woods, common.

P. monilifera Ait. Decatur, Appanoose, Shelby, and Johnson Cos. Rich woods, common.

P. alba L., var. *nivea*. Decatur Co. A frequent escape.

CONIFERÆ.

Juniperus virginiana L. Van Buren and Johnson Cos. River bluffs, frequent.

HYDROCHARDIACEÆ.

Elodea canadensis Mx. Johnson Co. Ponds, frequent.

Vallisneria spiralis L. Johnson Co. Infrequent.

ORCHIDACEÆ.

Microstylis ophioglossoides Nutt. Johnson Co. We have one specimen collected in low woods.

Liparis liliifolia Richard. Upland woods, frequent.

Aplectum hiemale Nutt. Johnson Co. Rich woods, infrequent.

Corallorhiza odontorrhiza Nutt. Johnson Co. Rich upland woods, common at least locally.

Spiranthes gracilis Bigelow. Johnson Co. Open upland woods, infrequent.

Goodyera pubescens R. Br. Johnson Co. Infrequent.

Calopogon pulchellus R. Br. Johnson Co. One specimen with three flowers on season's stem and two capsules on preceding year's stem was collected on top of a bluff in open woods.

Pogonia pendula Lindl. Johnson Co. Woods, infrequent.

Orchis spectabilis L. Johnson Co. Frequent locally.

Habenaria bracteata R. Br. Decatur and Johnson Cos. Woods, infrequent.

H. leucophæa Gray. Decatur Co. Low prairie, infrequent.

Cypripedium parviflorum Salisb. Crawford and Johnson Cos. Rich woods, frequent.

C. pubescens Willd. Decatur, Appanoose, and Johnson Cos. Rich woods, frequent.

C. spectabile Swartz. Johnson Co. Rich upland woods, infrequent.

C. candidum Muhl. Page Co. Infrequent.

IRIDACEÆ.

Iris versicolor L. Decatur and Johnson Cos. Along ponds, marshes, infrequent.

Sisyrinchium angustifolium Mill. Page, Decatur, Des Moines, Shelby, and Johnson Cos. Fields and open woods, common. White and blue flowered forms.

S. anceps Cav. Decatur and Johnson Cos. Open woods infrequent.

AMARYLLIDACEÆ,

Hypoxie erecta L. Decatur, Shelby, and Johnson Cos. Meadows and prairies, common.

DIOSCORIACEÆ.

Dioscorea villosa L. Decatur, Appanoose, Van Buren, and Johnson Cos. Woods, frequent.

LILIACEÆ.

Smilax herbacea L. Decatur, Appanoose, Shelby, and Johnson Cos. Woods, frequent.

S. hispida Muhl. Decatur and Shelby Cos. Woods, frequent.

S. ecirrhata Wats. Johnson Co. Woods, infrequent.

Allium tricoccum Ait. Decatur and Johnson Cos. Rich woods, frequent.

A. canadense Kalm. Decatur, Shelby, and Johnson Cos. Prairies and open woods, frequent.

Polygonum giganteum Dietrich. Decatur, Appanoose, and Shelby Cos. Low woods, frequent.

Asparagus officinalis L. Decatur, Van Buren, Shelby, and Johnson Cos. Waste places, infrequent.

Smilacina racemosa Desf. Decatur, Appanoose, Des Moines, Shelby, and Johnson Cos. Rich woods, common.

S. stellata Desf. Des Moines and Johnson Cos. Low places, infrequent.

Mianthemum canadense Desf. Johnson Co. Upland woods, infrequent.

Uvularia grandiflora Smith. Decatur, Appanoose, and Johnson Cos. Rich woods, frequent.

Oakesia sessilifolia Wats. Des Moines and Johnson Cos. Woods, infrequent.

Erythronium albidum Nutt. Page, Decatur, Van Buren, Shelby, and Johnson Cos. Low woods and fields, common.

Lilium philadelphicum L. Decatur, Shelby, and Johnson Cos. Prairies, infrequent, except Decatur Co., where the species is common.

L. canadense L. Decatur and Johnson Cos.

Trillium recurvatum Beck. Van Buren, Des Moines, Jefferson and Johnson Cos. Low woods, frequent locally.

T. erectum L. Shelby, Crawford, and Johnson Cos. Rich woods, infrequent.

T. nivale Riddell. Johnson Co. Upland woods, common.

Melanthium virginicum L. Decatur Co. Wet sloughs, common locally.

PONTEDERIACEÆ.

Pontedera cordata L. Appanoose and Johnson Cos. Borders of ponds, common locally.

Heteranthera graminea Vahl. Johnson Co. Borders of ponds, common locally.

COMMELINACEÆ.

Tradescantia virginica L. Page, Decatur, Appanoose, Des Moines, Shelby, and Johnson Cos. Prairies and fields, common.

JUNCACEÆ.

Juncus tenuis Willd. Decatur and Johnson Cos. Prairies and waysides, common.

J. nodosus megacephalus Torr. Decatur Co. Wet places, frequent locally

TYPHACEÆ.

Typha latifolia L. Decatur, Wayne, Appanoose, and Johnson Cos. Borders of ponds, common.

Sparganium eurycarpum Englm. Appanoose Co. In shallow water of Goose lake, common.

ARACEÆ.

Arisæma triphyllum Torr. Page, Decatur, Appanoose, Shelby, and Johnson Cos. Woods, common.

A. dracontium Schott. Decatur, Appanoose, Shelby, and Johnson Cos. Damp woods, frequent.

Acorus calamus L. Appanoose and Johnson Cos. Sloughs, frequent.

LEMNACEÆ.

Spirodela polyrrhiza Schleid. Decatur, Appanoose and Johnson Cos. Ponds, common.

Lemna trisulca L. Johnson Co. Ponds, common locally.

ALISMACEÆ.

Alisma plantago L. Decatur, Appanoose, and Johnson Cos. Ponds and flats, common.

Sagittaria variabilis Englm. Decatur, Appanoose, Shelby, and Johnson Cos Wet sloughs or shallow water, common.

S. heterophylla Pursh. Appanoose and Johnson Cos. Shallow water, common.

S. graminea Mx. Johnson Co. Margins of ponds and shallow water, frequent.

NAIDACEÆ.

Potamogeton spirillus Tuck. Decatur Co. In a railroad pond, common. Cratty: "This seems to be intermediate between this and *P. diversifolius* Raf. The submerged fruits are mostly peduncled in your specimens, while they are sessile, or very nearly so in true *P. spirillus* Tuck. Hitchcock collected the same at Hamburg."

P. fluitans Roth. Johnson Co. In ponds, common locally.

P. pauciflorus Pursh. Henry Co.

CYPERACEÆ.

Cyperus diandrus Torr. Johnson Co. Sandy soil along river, frequent.

C. speciosus Vahl. Decatur Co. Wet soil, frequent.

C. aristatus Rottb. Johnson Co. Sandy soil, frequent.

C. schweinitzii Torr. Johnson Co. Sandy soil, common.

C. filiculmis Vahl. Johnson Co. Sandy soil, frequent.

C. strigosus L. Decatur, Van Buren, and Johnson Cos. Low, sandy soil, common.

Eleocharis palustris R. Br. Decatur, Shelby, and Johnson Cos. Wet soil, common.

E. tenuis Schultes. Decatur Co.

E. acicularis R Br Johnson Co Wet soil, common.

E. ovata R. Br. Decatur and Appanoose Cos. Wet soil, or in shallow water, common locally.

Scirpus lacustris L. Decatur, Appanoose, Shelby, and Johnson Cos. Ponds or wet soil, common

S. atrovirens Muhl. Decatur, Shelby, and Johnson Cos. Wet soil, common.

Eriophorum polystachyon L. Johnson Co. Specimens collected by Prof. Shimek.

E. lineatum Benth & Hook. Decatur Co. Low prairies, frequent

Hemicarpha subsquarrosa Nees. Johnson Co. Sandy soil along river, infrequent

Scleria triglomerata Mx. Decatur Co. Prairies, frequent.

Carex intumescens Rudge. Appanoose Co. Wet woods, frequent.

C. grayii Carey. Appanoose Co.

C. squarrosa L Appanoose Co. Swamps, frequent.

C. hystricina Muhl. Decatur, Shelby, and Johnson Cos. Low grounds, common.

C. filiformis latifolia Boeckl. Shelby and Johnson Cos.

C. trichocarpa Muhl Shelby Co.

C. tricocarpa aristata Bailey. Johnson Co.

C. stricta Lam. Shelby and Johnson Cos.

C. davisii Schwein. & Torr. Johnson Co.

C. longirostris Torr. Johnson Co.

C. crawii Dewey. Shelby Co.

C. laxiflora Lam. Decatur and Shelby Cos.

C. laxiflora striatula Carey. Shelby and Johnson Cos.

C. granularis Muhl. Shelby Co.

C tetanica Bailey. Johnson Co.

C. pennsylvanica Lam. Decatur, Shelby, and Johnson Cos. Prairies and woods, common.

C. stipata Muhl. Shelby and Johnson Cos.

C. gravida Bailey. Johnson Co.

C. vulpinoidea Mx. Decatur, Appanoose, and Johnson Cos.

C. rosea Schkuhr. Decatur, Shelby, and Johnson Cos. Woods, common.

C sparganoides Muhl. Decatur Co.

C. cephalophora Muhl. Johnson Co.

C. tribuloides cristata Bailey. Decatur Co.

C. scoparia Schkuhr. Johnson Co.

C. straminea Willd. Decatur Co.

C. straminea brevior Dewey. Decatur, Shelby and Johnson Cos.

C. straminnea aptera Boott Johnson Co.

GRAMINEÆ.

Spartina cynosuroides Willd. Decatur and Appanoose Cos. Sloughs, common.

Panicum leibergii Schribn. Decatur Co. Meadows, frequent.

P. sanguinale L. Decatur, Wapello, Van Buren, and Johnson Cos. Fields and waste places, common.

P. capillare L. Decatur, Wapello, and Johnson Cos.

P. virgatum L. Decatur Co. Low prairies, frequent.

P. lanuginosum Ell. Decatur and Appanoose Cos. Meadows, frequent.

P. depauperatum Muhl. Johnson Co.

P. crus-galli L. Decatur, Wapello, and Johnson Cos. Wet grounds, common.

P. macrocarpon Le Conte. Decatur and Johnson Cos. Woods, frequent.

Setaria glauca Beauv. Decatur, Appanoose, Wapello, and Johnson Cos. Fields and waste places, common.

S. viridis Beauv. Decatur and Johnson Cos. With the preceding.

S. italica Kunth. Decatur, Van Buren, and Shelby Cos. Waste places, frequent.

S. verticillata Beauv. Johnson Co. Near dwellings, frequent.

Cenchrus tribuloides L. Decatur, Wapello, Van Buren, and Johnson Cos. Sandy soil, common.

Leersia oryzoides Swartz. Decatur Co.

Zizania aquatica L. Johnson Co. Ponds, frequent.

Tripsacum dactyloides L. Decatur and Appanoose Cos. Sloughs, frequent locally.

Andropogon furcatus Muhl. Decatur, Appanoose, and Johnson Cos. Prairies, common.

Chrysopogon nutans Benth. Decatur Co. Prairies, frequent.

Phalaris canariensis L. Johnson Co. An occasional escape.

P. arundinacea L. Johnson Co. Wet soil, infrequent.

Aristida oligantha Mx. Decatur Co. Dry soil, common.

Stipa spartea Trin. Decatur, Shelby, and Johnson Cos. Prairies, frequent.

Muhlenbergia mexicana Trin. Johnson Co. Low places, frequent.

Phleum pratense L. Decatur, Appanoose, Shelby, and Johnson Cos. Cultivated, a frequent escape.

Alopecurus geniculatus L. Johnson Co. Borders of ponds, infrequent.

Sporobolis cryptandrus Gray. Johnson Co.

Agrostis alba L. Decatur Co. Meadows, common.

A. perennans Tuck. Decatur Co. Frequent.

Cinna arundinacea L. Johnson Co.

Calamagrostis canadensis Beauv. Decatur Co.

Bouteloua racemosa Lag. Decatur, Appanoose, and Johnson Cos. Prairies, frequent.

Triodia cuprea Jacq. Decatur and Van Buren Cos. Sandy soil near water courses, common.

Kœleria cristata Pers. Decatur, Shelby, and Johnson Cos. Prairies, frequent.

Eatonia pennsylvanica Gray. Shelby and Johnson Cos.

Eragrostis reptans Nees. Decatur, Van Buren, and Johnson Cos. River banks, common.

E major Host. Decatur and Johnson Cos. Waste places, common.

E. purshii Schrader. Decatur and Johnson Cos. Waste places, frequent.

Melica mulica Walt. Johnson Co. Open woods, frequent.

Diarrhena americana Beauv. Decatur Co. Frequent.

Dactylis glomerata L. Decatur, Shelby, and Johnson Cos. Orchards and waste places, frequent.

Poa trivialis L. Shelby and Johnson Cos. Meadows and borders, common. This is frequently mistaken for *P. pratensis* L.

Glyceria nervata Trin. Decatur, Shelby, and Johnson Cos. Low prairies, common.

Festuca tenella Willd. Johnson Co.

F. shortii Kunth. Decatur Co. Low prairies, common.

Bromus secalinus L. Decatur and Johnson Cos. Fields and waste places, frequent.

B. ciliatus L, Decatur Co.

B. ciliatus purgans Gray. Decatur, Appanoose, and Johnson Cos. Rich woods, frequent.

Agropyrum repens Beauv. Decatur Co. Waste places, frequent.

A. spicatum (Pursh.) Scribn. & Smith. Shelby Co.

Hordeum jubatum L. Decatur, Shelby, and Johnson Cos. Waste places, common.

H. pussilum Nutt. Decatur and Johnson Cos. Waste places, becoming frequent. Johnson Co. specimens collected by Professor Shimek.

Elymus canadensis L. Decatur, Appanoose, Wapello, Des Moines, and Johnson Cos. Prairies and river banks, common.

E. striatus Willd. Johnson Co. Woods, frequent.

E. virginicus L. Decatur, Appanoose, and Johnson Cos. Prairies and woods, common.

Asprella hystrix Willd. Appanoose and Johnson Cos. Woods, frequent.

EQUISETACEÆ.

Equisetum arvense L. Decatur, Des Moines, Shelby, and Johnson Cos. Moist soil, frequent.

E. hyemale L. Decatur, Appanoose, Des Moines, and Johnson Cos. Wet places, frequent.

E. lævigatum Braun. Shelby Co. Fields and waysides, common.

FILICES.

Adiantum pedatum L. Decatur, Appanoose, Van Buren, Shelby, and Johnson Cos. Rich woods, common.

Pteris aquilina L. Upland woods, frequent.

Pellæa atropurpurea Link. Johnson Co. Cliffs, frequent.

Asplenium filix-fœmina Bernh. Decatur, Appanoose, Shelby, and Johnson Cos. Woods, common.

Camptosorus rhizophyllus Link. Johnson Co. Moist ravines, frequent.

Phegopteris hexagonoptera Fee. Johnson Co. Woods, frequent.

Aspidium thelypteris Swartz. Johnson Co. Boggy places, locally frequent.

A. aerostcihoides Swartz. Johnson Co. Rare.

Cystopteris bulbifera Bernh. Johnson Co. Base of cliffs, common.

C. fragilis Bernh. Decatur, Appanoose, Van Buren, Des Moines, Shelby, and Johnson Cos. Woods, common.

Onoclea sensibilis L. Decatur, Appanoose, and Johnson Cos. Moist woods, frequent.

O. struthiopteris Hoff. Shelby and Johnson Cos. Woods, common.

Woodsia obtusia Torr. Decatur, Van Buren, and Johnson Cos. Cliffs, frequent.

Osmundia claytoniana L. Decatur and Appanoose Cos. Moist woods, frequent.

OPHIOGLOSSACEÆ.

Botrychium virginianum Swartz. Decatur, Appanoose, Shelby, and Johnson Cos. Rich woods, frequent.

LYCOPODIACEÆ.

Lycopodium clavatum L. Johnson Co. Local, rare.

L. complanatum L. Johnson Co. Local, rare.

JUNGERMANNIACEÆ.

Lejunia serphyllifolia americana Lindl. Johnson Co. Base of trees, common.

Porella platyphylla Lindb. Johnson Co. On lime rocks and moist banks, common.

Cephalozia multiflora Spruce. Johnson Co. In moist situations, on ground among lichens, infrequent.

Lophocolea minor Nees. Johnson Co. On moist banks, infrequent.

Plagiochila asplenoides Dumort. Johnson Co. Moist banks, infrequent.

ANTHOCEROTACEÆ.

Anthoceros lœvis L. Johnson Co. Moist low grounds, frequent.

MARCHANTIACEÆ.

Marchantia polymorpha L. Johnson Co. Low grounds and over rocks, common.

Conocephalus conicus Dumort. Johnson Co. Rocks along shallow streams, common.

Asterella hemispherica Beauv. Johnson Co. On shady moist banks, common.

RICCIACEÆ.

Riccia crystallina L. Decatur and Johnson Cos. Fields and mud flats, common.

R. fluitans L. Johnson Co. Cratty sends us the same from Emmet Co. Floating on water, perhaps not common.

NOTES CONCERNING IOWA LICHENS.

BRUCE FINK.

It has been my good fortune, through connection with the Minnesota Botanical Survey, to be able to study the lichen-flora of a region extending from northeastern Iowa to the British possessions; and it is my purpose first of all to give a somewhat revised abridgment of a previous paper* dealing with the lichen-floras of certain localities within this region. The localities are Fayette, Iowa; Pictured Rocks, Clayton county, Iowa; and Minneapolis. I had originally intended to present merely an abstract of the original paper, but have finally decided that the only way to do justice to the subject is to give a more extended account from an Iowan point of view.

Also, in the interval of three years since my paper on Iowa lichens† appeared, I have been able to add a number of species new to the state, and a list of them is given at the close of the paper. The further study of areas within and without the limits of Iowa has given additional knowledge of the distribution of a few species previously reported, and I shall give some notes concerning these, stating why they are of special interest and in some instances where they are likely to occur in our state.

The only noteworthy differences between the vicinities of Fayette and Minneapolis as regards substrata suited to lichen-development are the presence of the Saint Peter sandstone at the latter place, which does not occur at the former, and the fact that the paleozoic limestones outcrop at the surface much more frequently at the former. The first difference is in favor of the lichen-flora about Minneapolis, and the second favors

* Contributions to a Knowledge of the Lichens of Minnesota, II Lichens of Minneapolis and Vicinity, Minn. Bot. Stud., Bull. No. 9, parts X and XI, pp. 703-726.

† Lichens of Iowa, Bull. Lab. of Nat. Hist., State Univ. of Iowa, vol. III, No. 3, pp. 70-88.

that about Fayette, as each of these substrata bears its characteristic lichens. As will be especially noted toward the close of these notes, these two differences about offset each other. The tamarack swamps about Minneapolis have no parallel about Fayette, and furnish lichens not found, or rare, in other parts of the former region. Yet all of these lichens occur about Fayette on one substratum or another, so that, in the comparison, the former region will gain nothing. Minneapolis has the larger river and the lakes, but not a single lichen has occurred near these bodies of water that is especially characteristic of such localities.

The following table, giving the genera and the number of species in each for the Fayette and Minneapolis vicinities, will be instructive and will form the basis for some further comparisons of the two regions:

GENERA.	No. of species Fayette.	No. of species Minn.	GENERA.	No. of species Fayette.	No. of species Minn.
Acolium	1	1	Opegrapha	2-2	1
Arthonia	5-1	3	Pannaria	2-1	2
Alectoria	1	1	Parmelia	9-1	8
Biatoria	13-3	6	Peltigera	6	6
Buellia	5-1	3	Pertusaria	4-2	3
Cetraria	1	1	Physcia	10-1	10
Cladonia	16	9	Placodium	10-1	10
Collema	7-1	2	Pyrenula	7-1	4
Coniocybe	1	0	Pyxine	1	0
Endocarpon	6	5	Ramalina	3	3
Evernia	1	1	Rinodina	4	3
Gyalecta	0-1	0	Staurothele	1	0
Graphis	2-1	1	Theloschistes	5	4
Heppia	1	0	Urceolaria	1-1	1
Lecanora	16-2	15	Usnea	4	4
Lecidea	2-1	1	Verrucaria	4-1	3
Leptogium	5	1			
Omphalaria	1-1	1	Totals	157-2	113

The collecting at Fayette extended over three years, and that at Minneapolis only over two months. Yet the collecting at the former place was my first extended work on lichens, and the best part of the work was confined to a single summer. The Fayette column I have divided into two parts, the first containing 157 species, which, with present experience, I should expect to find in a region as favorable for lichen-development as Fayette and in the time spent in collecting at Minneapolis. The second part of the Fayette column contains 23 species, so rare that one would not be so likely to find them in the short time, or which are not found within five miles of Fayette. The

113 species found at Minneapolis are about 72 per cent of the 157 species of Fayette lichens, and it will be an approximately correct estimate to say that lichens are one-fourth more numerous at the latter place than at the former.

The cause of the difference in number of lichens in the two places is evidently to be sought mainly in climatic differences. Several considerations have conspired to cause me to arrive at this conclusion.

First —Most species of lichens are more disposed to confine themselves to moist situations at Minneapolis, as about the bodies of water mentioned above, in heavy woods, or when in dry places near the ground. The last tendency is noticeable in *Graphis scripta* (L) Ach., which in dry places most frequently grows low down on the trunks of the trees. In passing up from the Mississippi river banks fifty to one hundred feet to the level ground just above the bluffs the decrease in number of species and individuals, whether on rocks, earth or trees, is very striking. In one place, within or near the city limits, the granitic boulders just above the bluffs are well covered with lichens, while twenty rods back from the river in open ground the rocks of the same kind are nearly bare of them. The decrease is not so marked in lichens growing on trees as in those growing on rocks, but is noticeable. I am not referring now to change in species in passing to the drier locality, which also occurs here as elsewhere, and is due to. stress caused by environment. Further, it may be said that a decrease would occur in numbers in other regions, but observation shows it to be more marked in dry climates. In parts of northern Iowa no such noticeable decrease occurs. Here fifteen or more species of lichens may easily be found on a single tree in moderately dry situations, and nearly all the species commonly occurring on the boulders in the vicinity of Fayette may be found on a single one in an open, dry field far removed from any stream.

Second.—The gelatinous lichens, which thrive in moist places, are much more common at Fayette. The first table will show that the genera *Collema* and *Leptogium* show twelve species at Fayette and only two at Minneapolis. I took special pains to investigate this peculiarity of distribution at the latter place, searching deep wooded ravines where these species should abound. It may be added that two of the three species given for the one locality are much rarer than any one of the twelve

given for the other. This adds to the evidence in a way not shown in the table.

Third.—The genus *Peltigera*, the species of which grow on the ground where they can get an abundance of moisture, is represented, by an equal number of species in the two localities compared, as will appear upon examining the first table. The individual *Peltigeras* are also about equally numerous in the two regions, the genus *Peltigera* being probably the best developed one of the flora about Minneapolis, though several other genera are represented by more species.

A thorough exploration of three or four selected areas along the Mississippi river, between the two localities compared above would, if made by one well acquainted with lichens and their habits of growth, bring out some very interesting and instructive information regarding lichen distribution. The first and second questions considered just above could thus be traced. As to where the gelatinous lichens decrease in number most rapidly in passing northward; and where the change from comparative uniformity of distribution, so far as influenced by the moisture or dryness of small adjacent areas, to greater lack of uniformity in this regard takes place most rapidly, are questions of interest.

The difference in number of species of lichens for the two localities compared is a greater per cent of the larger total than is the difference in number of genera. Fayette has thirty-four genera and Minneapolis twenty-nine. The difference in favor of the former place for genera is only 15 per cent, while for species it is about 28 per cent, or nearly twice as great. Reference to the table will show that the five Fayette genera (*Coniocybe*, *Gyalecta*, *Heppia*, *Pyxine*, and *Staurothele*), not thus far found at Minneapolis, are each represented at the former place by a single species. Hence, the 15 per cent has not the significance that it would have if it stood for genera well represented at one place and wanting at the other. On the whole, the less favorable conditions for lichen development at Minneapolis have affected the number of species vastly more than the number of genera.

Further knowledge of the distribution of the lichens about the two places can be gained by the consideration of the table below, in which I have given numbers of lichens for various substrata for Fayette and Minneapolis with the per cents which

these numbers represent of the whole number of lichens found in each locality on the substrata considered:

SUBSTRATA.	No. and per cent, Fayette.	No. and per cent, Minneapolis.
Wood	90 or 57 per cent	58 or 58 5 per cent.
Calcareous rocks	31 or 19 33 per cent.	17 or 17+ "
Granitic rocks	17 or 10.66 "	12 or 12+ "
St. Peter sandstone	0	5
Earth	23 or 13.75 per cent	12 or 12+ per cent.
Wood and rocks	15	5
Wood and earth	2	1
Rocks and earth	8	3
Total numbers	180	113

The table shows very little difference in the per cents of species on different substrata for the two localities, and this would seem to indicate that, though the drier climate of the Minnesota region has caused a poorer development of lichens than is found at the Iowa locality, it has not caused these plants to seek substrata especially favorable for their development. Other factors enter in to compensate differences which would otherwise occur to such an extent that the table shows in this respect just what it would not show were it not for these factors,—similarity as to number of lichens on different substrata for the two regions.

These other factors have prevented the development of a larger per cent of earth and rock lichens at Minneapolis. As climate becomes drier the relative per cent of these lichens should increase because nearer the earth there is more moisture. First as to the lichens on calcareous rocks, the per cent for Fayette is a little higher than that for Minneapolis, while the opposite condition should follow the difference in climatic conditions between the two places. This apparent difficulty is easily explained since the calcareous rocks outcrop at the surface much more frequently at the former locality. The lichen-species on calcareous rocks at Minneapolis are those confined in both places to perpendicular exposures, while one-third of the species found at Fayette are characteristic of surface outcrops. Deducting one-third of the 19.33 per cent given in the table for Fayette leaves less than 12.7 per cent and gives Minneapolis an advantage of more than 3 per cent for conditions as to substrata existing at both places. This is given as the true relation so far as influenced by the difference in hygrometric conditions.

Next as to the lichens on granitic rocks, the difference of 1.3 per cent in favor of Minneapolis is not so great as might be expected. This is due to the fact that so many of the granitic boulders are in dry open places. The few in moist or shaded places are reasonably well covered with lichens, but those not thus protected are not, as has been stated elsewhere. The limestone exposures are usually shaded along the wooded river banks, hence the advantage for these rocks would be greater than for the granitic rocks were it not for the lack of surface outcrops of the limestone rocks.

As to the earth lichens, the region including Minneapolis lacks the calcareous-earth lichens of the Iowa region, because the calcareous rocks are more deeply covered by drift and have not been so frequently exposed to help in soil formation. Of the twenty-two earth lichens found at Fayette seven occur on calcareous earth, while of the twelve found at Minneapolis only two occur on calcareous earth. Reducing the first number to fifteen and the third to ten gives Minneapolis an advantage of 3 per cent. This 3 per cent does not show the effect of atmospheric differences between the two places compared, because of the Minneapolis *Cladonias* only one-third occur on the earth, while of those at Fayette about two-thirds grow on the ground. Since I have been able to present no very satisfactory explanation of this difference in distribution of the *Cladonias* out of the calculation; and, if this were done, the advantage in favor of Minneapolis in the per cents would be about 2.5.

As to the wood lichens it will be seen that if the per cents of rock and earth lichens about Minneapolis were what we should expect from hygrometric conditions alone, the per cent of these would rise and that of the wood lichens would fall in comparative proportion. In other words, conditions other than atmospheric have tended to decrease the rock and the earth lichens, but not the wood lichens. Scarcity of lichens on trees removed from the large bodies of water and not in heavy forests has been noted elsewhere in this paper. As to lichens on dead wood, especially old boards, the Iowa region furnishes 14 and the Minneapolis region eight. The per cent of the whole lichen-floras in favor of the former region is about one. In the Minneapolis region the lichens on old boards are common enough in damp places, but in dry ones old boards are fre-

quently quite bare of them. In the Iowa region the old boards are abundantly supplied with lichens, even in dry places.

The reconstructed table below (which leaves the numbers of lichens for the substrata considered unchanged in the Minneapolis column except that for the earth lichens all calcareous earth lichens plus all earth *Cladonias* are omitted, treats the Fayette earth lichens in the same way and also deducts from the latter column all the calcareous rock lichens found on surface exposures) gives the relative per cents for all the substrata considered as influenced by atmospheric conditions alone:

SUBSTRATA.	NO. AND PER CENT, FAYETTE.		NO. AND PER CENT, MINNEAPOLIS.	
Wood	90 or 68+	per cent	58 or 62 3+	per cent.
Calcareous rocks	20 or 15+	" "	17 or 18 25—	" "
Granite rocks	17 or 12 8—	" "	12 or 12.8+	" "
Earth	5 or 4—	" "	6 or 6 5—	" "

This table simply places the per cents that would result from atmospheric conditions where they may be easily compared. However, by the reduction of the numbers representing earth and calcareous-rock lichens to eliminate other causes, it reduces the advantage for the Minneapolis vicinity in granitic rock species to a very small fraction. A somewhat larger number of such rocks were examined about Fayette, and possibly the larger number increases the number of species of lichens on them, which once established may now all be found on a few of the rocks. However, if the smaller number about Minneapolis is due to removal of the rocks, this argument loses much of its value. This table shows the relation between the wood lichens, as influenced by climate alone by per cents, which has not been done before.

The Saint Peter sandstone along the Mississippi river near Minneapolis, and that along the same river in northeastern Iowa, near McGregor, may be compared as to lichen-floras by use of the following table, which gives the species characteristic of these rocks in both places, and also those found on them in each place and not in the other:

SPECIES FOUND IN BOTH PLACES	IN NORTHEASTERN IOWA ONLY.	ABOUT MINNEAPOLIS ONLY.
Ramalina calicaris (L.) Fr. var Farinacea Schær.	Pannaria microphylla (Sw.) Delos.	Cladonia cæspiticia (Pers.) Fl.
Urceolaria scruposa (L.) Nyl.	Cladonia rangiferina (L) Hoffm. var Sylvatica L.	
Cladonia cornucopioides (L) Fr.	Cladonia uncialis (L) Fr.	
Usnea barbata (L.) Fr. var. rubiginea Michx.	Biatora granulosa (Ehrh.) Poetsch.	

This table affects comparisons thus far made in no way since the Iowa locality, now under consideration, is a different one than that previously used. In all the comparisons thus far made, the lichens on the Saint Peter sandstone have been eliminated with those of other substrata occurring in only one of the localities. Now, in the above table it will be noticed that the Iowa region has the advantage in the number of species not common to both. Knowing what occurs in Iowa, I examined the Minnesota locality very carefully, and the advantage is apparently due to the more favorable conditions for lichen growth in northern Iowa. The four species common to both regions are doubtless distributed along the river between the two localities wherever these rocks are exposed. How far north the four species found only in the Iowa locality extend, and how far south that found only in the Minnesota locality extends, are questions of interest. Knowledge on this point might lead to a modification of views just stated.

Usnea barbata (L) Fr. var. *Hirta* Fr., is also confined to the Saint Peter sandstone at the Minnesota locality, but not at the Iowa one, though occurring on this formation there also. This rock is apparently its most natural habitat in the regions considered, to which habitat it is confined in the one less favorable to lichen development. Though, as in this instance, I have omitted from the last table the species found on these rocks and also on other substrata near by in one or both regions, abruptness in floral change due to stress caused by change in substrata is seldom better illustrated than in comparing the lichens of the Saint Peter sandstone with those of other substrata that happen to lie adjacent. The distribution of lichens on this rock formation in Minnesota, Wisconsin, Iowa and Illinois is worthy of careful study. Other questions of distribution would be brought to light, illustrated by the species here considered, and doubtless by several others not yet collected on these rocks.

From scattered statements in this paper, the inference might be drawn that I should have given more prominence to difference of substrata in accounting for the difference in number of lichens in the localities compared. Minneaoplis gains six species on the Saint P ter sandstone, which is not found at Fayette, and lacks six species, occurring at Fayette, because the calcareous rocks seldom outcrop at the surface, and five species because of scarcity ‹ f calcareous earth. Possibly some allow-

ance should be made for a probable slight advantage for Fayette in number of granitic rocks, though Minneapolis has the advantage in the per cent of species on these rocks. Of the five species gain for Fayette in the figures given above, three or four, about 75 per cent, could be expected to occur at Minneapolis if the substrata were present. We could add as many more species for the possible advantage of Fayette in granitic rocks as substrata and still only have a total difference of seven species resulting from difference in substrata. This would reduce the advantage of Fayette to be accounted for by difference in atmospheric conditions to thirty-seven species or 24 per cent. Subtracting this from the total difference of 28 per cent, leaves a doubtful 4 per cent to be accounted for by lack of substrata at Minneapolis.

It may also be thought that I have not taken into account the usual decrease in number of species in passing from warmer to colder regions. The distance of about 150 miles from south to north between the two localities compared is so small that little difference in number of species could result, the difference in mean annual temperature being between 2° F. and 3° F. The smaller number of individuals at Minneapolis also tends to prove that the difference in latitude has not helped to produce the difference in number of species, as the decrease in number of species, caused by colder climate, usually gives place to an increase in number of individuals. If the difference in lichen-floras were due to the above cause, northern species should come in, to some extent, at Minneapolis, to take the place of those found at Fayette, and not at the former place. *Parmelia olivacea* (L) Ach., *Evernia prunastri* (L) Ach., *Cetraria ciliaris* (Ach.) Tuck., and possibly *Alectoria jubata* (L) Tuck var. *Chalybeiformis* Ach. are more numerous, and occur on more substrata at Minneapolis as a result of more northern location, but not a species has come in.

A comparison of the amount of precipitation of moisture at St. Paul and Fayette for the eight years since the record has been kept for the latter place, shows a difference in annual precipitation of 6.77 inches in favor of Fayette. Comparison of St. Paul and Dubuque for twenty-three years shows a difference of 9.31 inches per annum in favor of Dubuque. Now, comparison of Fayette and Dubuque for the eight years shows a difference of .50 inches per annum in favor of Fayette. Thus these last two places, only about fifty-five miles apart, show so

little difference in amount of precipitation that the Dubuque figures may be substituted for Fayette without great error. Also, St. Paul suffered less from the drouth of recent years than Dubuque, and hence than Fayette, so that the figures for the smaller number of years cannot be relied on, and 9.31 inches per annum doubtless is nearer the average difference between Minneapolis and Fayette in precipitation than is 6.77 inches. The use of St. Paul figures for Minneapolis can, of course, give rise to no appreciable error, and this difference of about 9.31 inches, with the accompanying difference of humidity of the atmosphere, seems to account very largely for the difference of 28 per cent in number of species of lichens. No reliable figures as to relative or absolute humidity could be obtained.

The following conclusions may be drawn relative to lichen-distribution in northeastern Iowa:

1. The lichen-flora of the region is richer than that of the Minnesota region about 150 miles north, and doubtless there is a gradual decrease in number of lichen species in passing north from the Iowa region.
2. The cause of the difference in favor of the Iowa region is neither its more southern location nor advantage in substrata, but mainly at least its moister climate. The proofs given in the paper may be briefly summarized as follows:
   (*a*) Lichens in the Iowa region are not so much inclined to confine themselves to moist situations.
   (*b*) Gelatinous lichens, which thrive best in moist places, are four times as numerous in the Iowa region.
   (*c*) Were it not for other than atmospheric conditions, the number of tree lichens would be larger in comparison with earth and rock lichens in northeastern Iowa.
   (*d*) Even the Saint Peter sandstone, occurring in moist places, has more lichens in the Iowa region.
   (*e*) The greater number of habitats of certain lichen species in northeastern Iowa must be included. This has been noted for *Usnea barbata* (L) Fr., var. *hirta* Fr., and a comparison of the number of species found on both wood and rocks at Fayette and Minneapolis, as shown in the second table, is further evidence. Other instances could be drawn from a comparison of the lists of species for the two places.

After giving this brief summary it may be stated that the decrease in richness of lichen-flora changes to an increase somewhere between Minneapolis and Duluth, as will be brought out in a future paper on the lichens of Minnesota.

As regards other Iowa problems, the most interesting region in connection with the study here presented is that extending along the Mississippi river from the northeastern region already studied to the southern extremity of the state. The study of this area, besides the information it would furnish concerning the lichen-flora of our own state, is especially necessary to an understanding of lichen-distribution along the upper Mississippi river. The study of more western portions of Iowa will bring new problems and also throw some light on those here considered.

Below is added the lists of new and rare Iowa lichens mentioned in the first part of this paper. These with two given for locality bring the total number of species and varieties which I have collected and determined at Fayette up to 208. These additions make a total of 226 species for the state, and this number could be increased largely by thorough work in several widely separated regions within Iowa.

LIST OF SPECIES NEW TO IOWA.

Usnea barbata L. Fr., var. *ceratina* Schær. On trees, rare. Fayette.

Alectoria jubata L., var. *chalybeiformis* Ach. On an old board fence, rare. Fayette. Also on Saint Peter sandstone in Clay ton county.

Theloschistes concolor Dicks, var. *effusa* Tuck. On trees, rare. Fayette. Since publishing the first paper on Iowa lichens I have also found at Fayette a form of the species with fibrils unusually developed about the apothecia. They are frequently as long as the diameter of the apothecia!

Parmelia saxatalis L. Fr., var. *sulcata* Nyl. On trees, rare. Fayette.

Parmelia olivacea L. Ach., var. *aspidota* Ach. On trees, infrequent. Fayette.

Pannaria nigra Nyl., var. *cæsia* Nyl. On calcareous rocks, rare. Fayette.

Collema nigrescens Huds., Ach. On old logs, rare. Fayette. Frequently with pruinose apothecia.

Placodium ferrugineum Huds., Hepp. On trees, rare. Bremer and Fayette counties.

Placodium murorum Hoffin, DC. On rocks. Northwestern Iowa. Coll., Prof. B. Shimek, who sent it to me last year. It should have appeared with the lichens listed in his paper* last year, but I could not be sure that it was distinct from *P. elegans* Link, DC., without further study.

Lecanora pallida Schreb, Schær, var. *cancriformis* Tuck. On trees, rare. Fayette.

Lecanora varia Ehrh, Nyl., var. *symmicta* Ach. On old fences, infrequent. Fayette.

Lecanora cinerea L. Sommerf. On sandstone, probably common. Clayton county.

Lecanora fuscata Schrad., Th. Fr., var. *rufescens* Th. Fr. On granitic rocks, frequent. Fayette.

Lecanora priqigna Ach., Nyl., var. *clavus* Koerb. On calcareous rocks, rare. Clayton county.

Lecanora xanthophana Nyl. On granitic rocks, rare. Fayette and Bremer counties.

Rinodina sophodes Ach., Nyl., var. *telhraspis* Tuck. On sandstone, rare. Clayton county.

Conotrema urceolatum Ach., Tuck. On trees, rare, Fayette.

Biatora decipiens Ehrh, Fr. var. *dealbata* Auct. On calcareous earth, rare. Fayette.

Biatora russellii Tuck., var. *dealbata* Tuck. On calcareous rocks, rare. Fayette.

Biatora fossarum Duf., Mont. On calcareous earth, rare. Fayette.

Biotora carnulenta Tuck. On decorticated wood, rare. Fayette, and also from Black Hawk county, collected by Mr. Morton E. Peck.

Buellia myriocarpa DC., Mudd., var. *polyspora* Willey. On tree, rare. Fayette. This rare lichen was also sent to me from Decatur county by Prof. T. J. Fitzpatrick and from La Crosse, Wis., by Prof. L. H. Pammel. A larger form collected by Mr. Morton E. Peck in Black Hawk county must also be referred here for the present.

Buellia alboatra Hoffin, Th. Fr. On an elm tree, rare. Fayette.

Opegrapha quaternella Nyl. On thallus of a Parmela, rare. Fayette. I have not been able to compare this, but it agrees

* The Flora of the Sioux Quartzite in Iowa. Proc. Iowa Acad. Sci, vol. III, pp. 73-77.

perfectly with the description, having spores 4 in asci, 4 celled, brownish and 16–19 x 5–6 mic.

Calicium parietinum Ach. On decorticated wood, especially red cedar, probably frequent. Fayette.

Calicium quercinum Pers. On oaks, rare. Fayette.

Sphinctrina tigillaris B. and Br. On *Polyporus versicolor* L Fr., rare. Fayette. Placed here because of close relationship to the last two, though the algal cells probably are wanting in this. Perhaps better to place it in the above genus under the synonym, *Calicium polyporæum* Nyl.

Verrucaria epigœa Pers., Ach. On clay, rare. Fayette.

Pyrenula cinerella Flt., Willey. On prickly ash, frequent. Fayette.

Thelocarpon prasinellum Nyl. Old boards, frequent. Fayette and Bremer counties.

NOTES CONCERNING SOME SPECIES PREVIOUSLY REPORTED FOR IOWA.

Evernia prunasuri L., Ach. I have recently found this species on old board fences at Fayette. Thus far it has not occurred elsewhere in the state, though it is very common in northern Minnesota and frequent as far south as Minneapolis. Its southern limit is doubtless reached somewhere in Iowa.

Pycine sorediata Fr. This lichen was only listed in the paper on "Lichens of Iowa" from rocks. It has since been found in fruit on trees at Fayette. It becomes more common in passing north to the British possessions, and its distribution in other parts of Iowa is especially worthy of study.

Sticta pulmonaria L., Ach. Only known thus far in Iowa along the Mississippi river in Clayton county. How far this northern lichen extends south along the river, or possibly in other parts of Iowa, is of special interest. Like the last two, I find it increasing in abundance as I go north.

Pannaris languinosa (Ach.,) Koerb. I have recently collected the sulphur colored form, common in Europe, on the Saint Peter sandstone in Clayton county and in several localities in Minnesota.

Lecanora punicea Ach. Any further occurrence of this in Iowa should be noted, because it is a southern lichen, and it finds its most northern known limit in Iowa.

Lecanora varia Ehrh, Nyl., var. *sæpincola* Fr. This rare Iowa variety was sent from Black Hawk county Coll., Morton E. Peck.

Lecanora privigna Ach., Nyl. var. *pruinosa* Auct. On calcareous rocks, frequent at Fayette. Previously reported from Johnson county.

Cladonia cariosa Ach., Spreng. This species only reported from Johnson county, is common in northern Minnesota. In Iowa it seems to be largely replaced by the more southern *C. mitrula* Tuck. Especially interesting because the southern limit of the one and the northern limit of the other may be looked for in Iowa or Minnesota.

Cladonia cornucopioides L., Fr. Collected only along the Mississippi river in Clayton county. Another species apparently following the river down from more northern regions where I find it common. Should be diligently sought further south in Iowa, especially along the river.

Biatora granulosa Ehrh., Poetsch. Found with the last, which is as far south as it is known, except in mountains. Should be sought further south, as the last.

Biatora inundata Fr. I have recently collected this lichen on trees. Previously reported from several places, but only on rocks.

Arthonia dispersa Schrad., Nyl. On trees. Black Hawk county. Coll., Morton E. Peck.

Endocarpon pusillum Hedw. var. *garoqaglii* Kph. On calcareous rocks, infrequent, Fayette. I have also collected it in Kane county, Ill., from which state it has not been previously reported.

Verrucaria fuscella Fr. On calcareous rocks. Black Hawk county. Coll., Morton E. Peck.

Verrucaria muralis Ach. On calcareous rocks. Black Hawk county. Coll., Morton E. Peck.

It is worth noting that the last two rather rare species have been collected at La Crosse, Wis., by Prof. L H. Pammel. Also, the last was sent me by Mr. E. Bartholomew, from Rooks county, Kan.

DO THE LOWER ANIMALS REASON?

C. O. NUTTING.

For the average layman to enter into a discussion involving psychological matters is surely a rather hazardous proceeding and indicates a temerity that needs some apology.

Your speaker, although not a psychologist, has become greatly interested in the evidences of mind that have impressed themselves upon him in his study of animals, and has had his interest greatly stimulated by the perusal of the works of two writers, one of whom discusses animal psychology from the side of the naturalist, and the other from the side of the psychologist. With the latter writer I have been led into the most delightful correspondence involving a discussion of the question "Do the lower animals reason?" a question upon which I have been forced to differ from the gentleman in question

I referred a moment ago to the difficulty involved in a psychological discussion. This difficulty is two-fold, arising first from the necessity of exact and very careful definitions of terms, and sec nd, from the great tendency to be drawn off into a discussion of side issues, which, however alluring are not strictly pertinent to the matter in hand.

It is my purpose to discuss briefly the attitude of the two authors above mentioned, Romanes and Lloyd Morgan; to point out my objections both to the premises and conclusions of the latter, to state with all diffidence my own position in the question, and finally to cite a sufficient number of facts to justify that conclusion.

George J. Romanes, an English zoologist, whose untimely death has been a severe loss to science, has written two works on "The Intelligence of Animals," and "Mental Evolution in Animals." He has sought to establish a thoroughly consistent scheme of development of mind along evolutionary lines. The following propositions will indicate the keynote to his position.

Evidence of choice on the part of an organism is a criterion of mind.

The evidence of choice is a discriminating response to stimuli.

Sensation is feeling aroused by stimulus.

Memory arises from the after-effect of a stimulus and leads to the association of ideas and recollections.

Perception is an establishment of specific relations among states of consciousness. It is a mental interpretation of sensations in terms of past experience. It is everywhere bound up with memory, and in its highest stages involves inference. According to this writer all but the very lowest invertebrates among animals give evidence of perception.

Instincts originate in two ways.

First.—By natural selection, by which fortunate actions, although not intelligent, being of advantage, lead to the preservation of the individuals showing such activities.

Second.—By the effects of habit in successive generations, actions which were originally intelligent, become, as it were, stereotyped into permanent instincts.

"Reason is the faculty which is concerned in the intentional adaptation of means to ends. It therefore implies the conscious knowledge of the relation between means employed and ends attained, and may be exercised in adaptations to circumstance, novel alike to the experience of the individual and to that of the species."

Mr. Romanes is very strongly of the opinion that a great number of the acts of the lower animals indicate reason as above defined. We will not, however, enter at present on the discussion of this question. I wish merely to point out and emphasize the fact that this able writer, approaching the question from the standpoint of the naturalist, has no doubt whatever that the lower animals reason. C. Lloyd Morgan of Bristol, England, is, I believe, regarded as one of the leading psychologists of the day, has written an extensive work on human psychology, and a smaller, but thoroughly scientific treatise called "An Introduction to Comparative Psychology." He is probably more admirably trained for philosophical discussion than was Romanes, and impresses one as a thinker of unusual ability and accuracy. His style is remarkably clear and lucid, and his writings show little of the intellectual dishonesty that is apt to mar the work of the ordinary controversialist.

He adopts the "wave theory of consciousness." The crest of the wave is the focal point of consciousness. The slopes of the wave are marginal and represent elements which, although not focal, are still dimly within the field of consciousness. They are sub-conscious. It will be seen that that which is marginal at one instant becomes focal with the advancing wave and is for a season again marginal as the wave passes forward.

It will be noted that the wave of consciousness is continuous and this continuity of consciousness is what Morgan calls mind.

The following canon of interpretation is enunciated by this writer as a law that must be followed in interpreting psychical phenomena other than our own, particularly non-human psychical activities.

"In no case may we interpret an action as the outcome of an exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale."

We shall have occasion to discuss this canon further on. I will simply remark in passing that it forms the main line of contention in the correspondence between Professor Morgan and myself.

The following definitions of terms are the ones adopted by Morgan, and indicate the sense in which the words are used in this paper. Only such terms as are necessary to the discussion need occupy our attention at pre·ent.

An instinctive act is a sub-conscious motor response to a stimulus and precedes experience. Example, a newly hatched chick will at once begin picking at small objects on the ground. Newly born kittens will spit at a dog.

Intelligent action is one based on previous experience. Example, the young chick will after a little experience pick at small seeds and refuse to pick at grains of sand. Young kittens will not notice a dog with which they are acquainted, but will spit at a strange dog.

Association of ideas may be explained by again referring to the wave theory of consciousness.

When in past experience the wave has passed through a given series involving a number of sense impressions, any one of those sense impressions received on a subsequent occasion may start again the same wave and cause the same, or some of the same, impressions to again be present in consciousness. And

the oftener this is done the more certain is this group of impressions to recur when one of them is presented as fo:al in consciousness. For example I can never, try as I may, avoid the recurrence of a mental picture of two little swampy Cree Indians with their mouths wide open, whenever I hear the music of that grand old church hymn "Onward Christian Soldiers."

Morgan distinctly admits the presence of the wave of consciousness in animals. He further admits, as indeed do all men who have thought on the subject, that the phenomena of association of ideas is constantly in evidence in animal psychology. It is also evident that these associations once formed are the basis of intelligent action.

The young chick associates the sense impression conveyed by a seed with the pleasurable sensation caused by eating it.

In the future, therefore, he unhesitatingly eats the seed as soon as he sees it. The grain of sand is not associated with a p'easurable gustatory sensation and he lets it alone. In other words, intelligence is guided by sense experience.

"Memory is the reinstatement or revival, through secondary suggestion, of psychical elements or constituents which have faded from consciousness." It works apparently through association of ideas.

Memory is involuntary while recollection is voluntary.

Memory may be a simple reinstatement, or in its higher phases it may involve a definite localization in time of past events. I the latter event it has to do with relation, some reference to the how, where and when.

Our author believes that many animals habitually exercise memory in the sense of a simple reinstatement through suggestion. He does not believe that they exercise the higher memory that involves the perception of relations.

"A percept is an impression to which is added a conscious or sub-conscious perception of relation to the subject or to other objects."

In our wave of consciousness, the attention is focused on various objects in succession. It is transferred rapidly from one to another The consciousness of the transition is marginal. Now if we can go back again and focus the attention in the transition itself, we are engaged in perceiving the relation of the two objects, whatever they may be. This operation involves retrospection. Our author here goes into a maze of

nice distinctions through which we cannot follow him. He believes, in fine, that while animals lower than man have an awareness of relations, the transitions are marginal in consciousness; he denies that they are able to make the transitions focal, thereby arriving at a perception of relations. He does not believe that animals can reflect.

Finally, let us see our author's definition of reason, or rather the criteria of reasoning powers. He says, "Our question then becomes: Are there animal activities the performance of which is inexplicable if the animal in question does not perceive the 'why' and think the therefore." He says that there are none. While admitting that animals do reason in the sense that they profit by experience, adapting their actions to somewhat varying circumstances, he does not believe that they reason in the more restricted sense of having a real perception of cause and effect or the true relation between a premise and a conclusion.

To this position I cannot assent and have certain objections to raise in behalf of my friends, the lower animals.

As an example of Professor Morgan's method of interpreting actions which we would unhesitatingly regard as involving reason, I quote the following;

"A well known writer describes the case of a dog which used to hunt a rabbit nearly every morning down a curved shrubbery, and each time ran it into a drain at the end. The dog then appears to have come to the conclusion that a chord of a circle is shorter than its arc, for he raised the rabbit again, and, instead of following him through the shrubbery as usual, he took the short cut to the drain, and was ready and waiting for the rabbit when he arrived, and caught him." Now, says Morgan, "Can we or can we not explain the dog's action as the outcome of sense experience, as indicative of intelligence profiting by association? The terrier used to start the rabbit nearly every morning, and each time saw it escape into the old drain. There was thus ample opportunity for establishing an association between rabbit and drain. That the sight of the rabbit should suggest the drain into which it daily escaped, and that when the idea was suggested, the dog should run there directly, is a sequence not impossible, one would think, to sense experience."

It seems to me little short of absurd to suppose that the dog in his eager and frantic chase after the rabbit could be induced

to leave it in order to go to the drain on account of a mere unreflective association of the idea rabbit with the idea "drain." That he did not in a true sense know why he went. That he did not focus the therefore as a result of his past experience and his knowledge of the short cut.

No matter how apparently conclusive may be the evidence that an animal has reasoned in a given instance Professor Morgan will refer it all to sense experience, as in the case cited. Indeed, I do not see how a human being could, without language, give evidence of reason that could not by a similar course of logic, or rather hypothesis, be referred to sense experience.

I cannot help thinking that Professor Morgan has fallen into two serious errors, the first of which is the adoption of the canon of interpretation before referred to. Let us state this canon again:

"In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale."

My objection to this law of interpretation may be briefly stated as follows: "Where two organisms are so very much alike in anatomy, histology, physiology, embryology, etc., as are man and the anthropoid, where there is strict homology in so many thousands of particulars, the assumption is that this homology extends to mental phenomena which are apparently alike." Mr. Morgan in a recent letter explicitly agrees to this statement, and adds: "For this reason I believe that the mental phenomena of men and brutes are continuous and like in kind." I am so far unable to reconcile this last statement with the trend of his argument in the work referred to above. and especially in the following statement: "And I believe that the extraordinary difference between men, even the lowest, and animals, even the highest, is due to the introduction of the new factors involved in the perception of relations and conceptual thought."

It seems to me that we would be more apt to arrive at a just conclusion if we should adopt some such law of interpretation as the following:

When judgment is to be passed in the psychological activities of animals morphologically and physiologically like men in thousands of particulars, it is fair to conclude that this like-

ness extends to the realm of psychology, and that activities which would unhesitatingly be ascribed to reason if exhibited by man, should be regarded as evidence of reason when exhibited by organisms closely allied to man, until evidence to the contrary is forthcoming.

It is entirely unnecessary in this presence to show the very great likeness in morphology and physiology between man and the other mammalia. The more minute our investigations, the more are we impressed with this similarity. Almost every bone found in the one is found in the other. A striking illustration of this similarity was furnished lately when a taxidermist used the skeleton of the human hand as an aid in articulating the bones of a fore-foot of the wombat, an animal at the opposite end of the mammalian series. "But," it may be objected, "the great physical difference between man and brute is in the brain." Granted. But the difference is quantitative, not qualitative. So far as I know there is no kind of brain cell in man that is not found in the brute. The difference in quantity is enormous, but that in quality is yet to be discovered.

In physiological matters the same conclusion is inevitable. The various organs in animals are strictly homologous with those of man in structure and also in function. They act, in general, in the same way in both under similar conditions. But that which is rightly regarded as most conclusive of all is the fact that medicines and poisons act in the same way in both. When we know the effect of a certain drug in man we can confidently predict the same effect would ensue if the dog were treated with that drug. It is also true in general that the same diseases affect man and the apes, for instance, in the same way. Consumption might almost be said to be the natural death of captured monkeys, so prevalent is it

I maintain, then, that we have a perfect right to insist that in view of these innumerable homologies, the overwhelming presumption is in favor of like actions being indices of like mental states in both; and that when a given activity on the part of an animal appears to indicate the exercise of reason, the assumption is that the animal does reason, and that assumption logically stands until it is swept away by conclusive evidence to the contrary.

It will be seen from what I have already said that Professor Morgan, in contemplating the apparently rational acts of animals, demands that they be regarded as irrational if it is

possible to conceive of them as being on the plane of sense experience pure and simple. I, on the other hand, in contemplating the same apparently rational activities, assume that they *are* rational until it is proved that they are not.

The second point on which it appears to me that Professor Morgan is mistaken is in his treatment of the perception of relations. His conclusion that the lower animals are unable to perceive relations appears somewhat arbitrary, and open to several objections, the first of which is a thoroughly theoretical one, and may or may not be of weight, although perhaps not unworthy of consideration. Mr. Morgan adopts the wave theory of consciousness for both man and brutes. He admits that the relation is present in the mind of the animal, but says that it is always marginal, never focal. Now, we know, or perhaps it would be better to say that I think I know, that anything that is marginal in human consciousness may become focal. For instance, as I stand before this audience a certain individual becomes focal in my consciousness. My attention is fixed on him; all of the other persons in the room may be regarded as marginal. Now any of these latter may become focal. In other words, I can fix my attention upon any of the things that are marginal or of which I am sub-consciously aware. An opposite state of affairs seems to be the case in dreams. In these we appear to have no control whatever over the wave of consciousness, and the most incongruous impressions result. It appears, moreover, that in the dreaming state the incongruity of the most absurd relations does not strike or impress the consciousness in the least Perhaps I should not deal with this subject at all, not having studied it sufficiently, but it appears to me that we have in the dream state an example in which the perception of relations is at least reduced to a minimum; in dreams we never, so far as I know, focus the "how" and "why." Moreover, if my own experience be a guide, dreams are in a marked degree irrational and incoherent. There is no consecutiveness of purpose. A waking man acting as he would in a dream would at once be judged as insane. It may be remarked in passing that there is almost as marked a difference between a sane and insane animal as there is between a sane and insane man.

To return from our digression, man can render focal to consiousness anything that is marginal in consciousness. The question then arises, can the other mammalia do the same thing?

A dog is chasing a rabbit upon which his attention is fixed. He hears the whistle of his master, which is at first marginal to his consciousness; upon repetition it becomes focal. Indeed, if the wave theory applies to the consciousness of animals at all, nothing becomes focal without first becoming marginal in the dawning consciousness that constitutes the front of the wave. This point would, of course, be admitted by Professor Morgan.

Now, admitting as he does, that the relation as such is marginal in the mind of the dog, what warrant has he to assume that it never becomes focal? If this is true, what earthly reason would this be for the dog who is chasing the rabbit to leave that interesting occupation to go to the drain? He could not eat the drain, and so far as the story shows has never attained any satisfaction from the drain in his past experience. On the contrary, the drain must be associated in his mind, not only with the rabbit, but with repeated disappointment and chagrin. Hence, on the very principles which Mr. Morgan insists upon throughout the work, the drain being associated in the dog's mind with unpleasant experiences, would be an object of aversion, and, if sense impressions alone controlled him, he would run away from it as soon as it was present in consciousness through association. Personally, I am unable to avoid the conclusion that the dog knows perfectly well *why* he leaves the direct trail of the rabbit and takes the short cut to the drain. He knows from past experience that he cannot catch the rabbit by following him into the drain. He knows that the short cut is the nearest to the drain. He takes the short cut and *expects* to see the rabbit. I cannot avoid the conclusion that he has reasoned in the most exact sense of the word. That he has focused the relation between the longer and shorter paths and also that between the rabbit and the drain. He has focused the *how* to outwit the rabbit, and the how cannot be focused without a definite perception of relation.

As before intimated, my personal knowledge of the pyschology of dreams is too limited to permit of my discussing it with confidence, but it appears to me that dreams are governed by association of ideas alone, or nearly so, and that here we have a case of mental action in which the relation is not focal. I should, therefore, expect an animal unable to focus the relation, unable to reflect, to act as does a person in a dream. This animals seldom do. Their actions are consecutive. They

appear to have definite purposes, to form plans and act upon them, both intelligently and rationally.

Again, it may be urged that the focal and marginal intergrade so completely that it is impossible as a matter of fact to distinctly separate them in consciousness. For example, I say that a certain person in this room becomes focal in my consciousness. This is inexact because, perhaps, I see only a small part of that person, perhaps the head and shoulders; or my attention may be fixed on his eyes alone and all the rest may be focal. In practice, then, it is almost impossible to sepa- the marginal from the focal, just as it would be almost impossible to discriminate exactly between the crest and body of a wave We know in general what is meant by the terms, but the one blends completely with the other as an actual fact. But this distinction between marginal and focal is the very thing upon which Morgan bases his denial of reasoning to the brutes. He says that in animals the relation is marginal, but never becomes focal. How can he assert this thus positively when focal and marginal denote completely interblending parts of the wave of consciousness? How can he maintain his position in the face of the fact that in actual practice we cannot clearly distinguish the two?

To sum up the argument.

First.—The canon of Morgan appears to be an unjust and inexact law for the comparison of mental phenomena by these physical manifestations in conduct because it ignores the multitude of homologies that exist between man and the higher mammalia.

Second.—These homologies should justify us in assuming that like activities in man and mammals are indices of like mental causes to psychological processes, unless we have independent evidence to the contrary.

Third.—Experience and observation prove that that which is marginal in consciousness may become focal in both man and animals. If this be true the burden of proof rests with those who say that one particular kind of marginal impression never becomes focal in mammals lower than man.

Fourth.—The psychology of dreams may furnish an example of mental activity which is composed of sense impressions or reinstatements without the relations becoming focal. Animals do not act as if dreaming, but show continuity both of conduct and of purpose.

Fifth.—The distinction between marginal and focal cannot be actually drawn either in theory or practice. It is, therefore, too small a one upon which to distinguish rational from irrational conduct. Or if a distinction be drawn upon this basis the difference cannot be great.

It will be seen that I have thus far argued the question propounded at the beginning of this paper entirely from the theoretical or speculative side, leaving no time for the presentation of examples that in my opinion indicate that the lower animals reason. Such instances are so numerous, that no one at all conversant with the matter can doubt that the animals at least appear to reason. As a matter of fact that is all that we can assert in the premises. Moreover, a moment's reflection will suffice to show that this is all that any one of us can positively assert of any other human being. That he *appears* to *reason*. It is just as impossible for one person to enter into the consciousness of another human being as it is for him to enter into the consciousness of one of the brutes.

COMPARATIVE ANATOMY OF THE CORN CARYOPSIS.

L. H. PAMMEL.

The fruit, or what is popularly known as the seed, of corn has been studied by a number of investigators, as Harz[1], Hunt[2], Goodale[3], Hackel[4], Jumelle[5], True[6], and Blyth[7]. The literature on the structure of the corn caryosis is quite large; many of the works on foods discuss the subject.

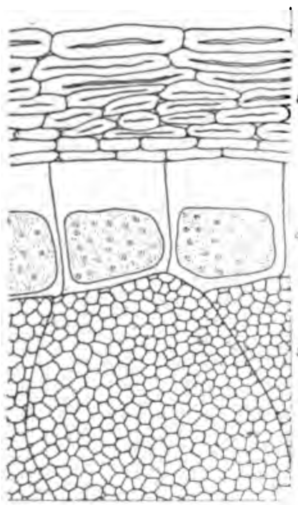


Fig. 5
Flint corn. *a*, epidermis; *c*, capsule and testa; *d*, aleurone layer; *s*, starch cells

The outer part of the so-called seed is the wall of the ovary. It begins with a greatly thickened epidermis (a); this is followed by a variable number of rows of thick-walled cells provided with pore canals. The wall of the ovary is frequently differentiated into several layers, usually two, and a third more difficult to make out, the inner part being less thickened than the outer. This layer contains some of the pigment in the colored varieties. The cells contain only small amounts of protein matter. The cell-walls are greatly thickened.

The wall of the ovary closely joins the testa of the seed. But one coat remains in the mature seed, the inner, the outer being absorbed in development. The testa is insignificant since the protective features are supplied by the thickened wall of the ovary. The cells are elongated, thin-walled, and

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1 Harz Landwirthschaftliche Samenkunde. 2:1235.

2 Hunt, F. L. A kernel of Indian corn. Prairie Farmer. 58: 196. Thirteenth Rept. Board of Trustees of Univ of Ill. 196. 1886

3 Goodale, G. L. Physiological botany. 181.

4 Hackel, Edward The true grasses. 24-25. (Eng. trans. by F. Lamson-Scribner and Effie A. Southworth)

5 Jumelle. Sur la constitution du fruit d. graminees. Soc. d. Sci. Nancy. Seanc. 23 Juillet, 1888. (According to Knoblauch. Just Bot. Jahresb. 16: (5) 1888.)

6 True. On the development of the caryopsis. Bot. Gaz. 18: 214. *pl.* 24-26. *f.* 10.

7 Blyth. Foods, their composition and uses. 216. (4th ed.)

in some cases may be differentiated into two parts. The remains of the nucellus may be made out in the region of the

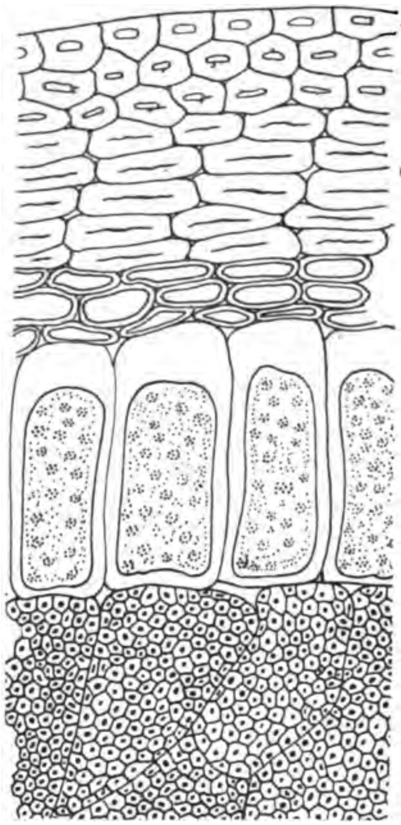


Fig. 6.
Dent corn. *a*, epidermis; *c*, capsule; *t*, testa; *a'*, aleurone cells; *s*, starch cells.

hilum. The endosperm and embryo constitute the most important part of the seed from an economic standpoint. The first layer of the endosperm consists of the aleurone. This is made up of cells nearly uniform in width and length, and surrounds the endosperm. These cells in colored varieties contain some of the pigment. In some cases the cells are somewhat longer than broad.

The wall joining the testa is greatly thickened and in some cases provided with minute canals, which connect adjoining cells.

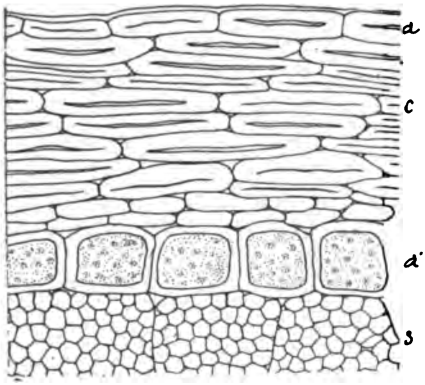


Fig. 7.

Popcorn. *a*, epidermis; *c*, capsule; and testa; *d*, aleurone layer; *s*, starch.

The walls of the endosperm consists of pure cellulose. The cells are densely filled with protein grains, but no starch. The so-called gluten meal of commerce consists of the wall of the ovary, the testa, the aleurone layer and some starch cells. The layer following the aleurone consist of thinner-walled, somewhat irregular, but usually elongated cells filled with starch, at least in our dent and flint corns. The starch grains appear regularly striated and with a "nucleus."

The embryo is surrounded by a small and regular row of cells where it joins the endosperm. These are followed by the

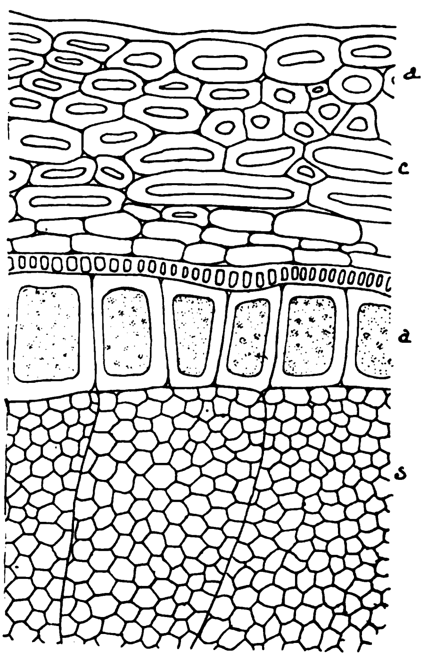


Fig. 8.

Popcorn. *a*, epidermis; *c*, capsule; and testa; *d*, aleurone layer; *s*, starch cells.

larger cells of the scutellum. They contain some starch, considerable fat, but mostly protein. The cells of the plumule

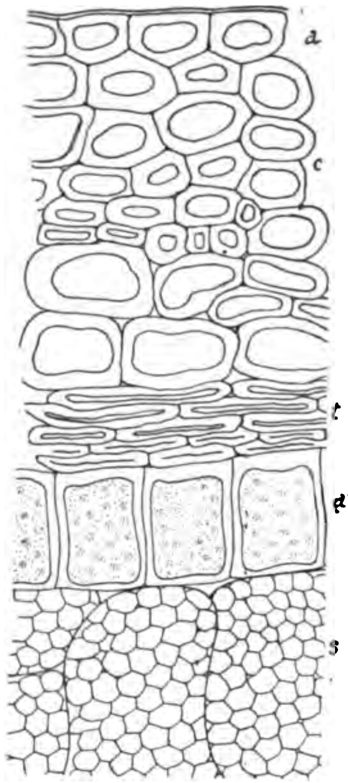


Fig. 9.

Mexican corn, popcorn type. *a*. epidermal cells of capsule; *c*, capsule; *t*, testa; *a*, aleurone cells; *s*, starch layer.

and caulicle are smaller and contain only protein grains. The largest amount of nitrogen is therefore found in the embryo.

We may now discuss some varietal differences. Harz has indicated some differences but the varieties studied by him were not named. In yellow dent and popcorn the starch grains are solidly packed. The starch grains of the popcorn are much larger. The outer cells of the wall of the ovary are larger and more elongated. The cell-walls of the aleurone layer are provided with pore canals. In the Mexican corn of the popcorn type the wall of the ovary has large cells and those of the testa are also large. These cells as well as the aleurone cells are colored brown. In the Mexican sweet corn the blue pigment is carried in the aleurone layer as well as in the testa.

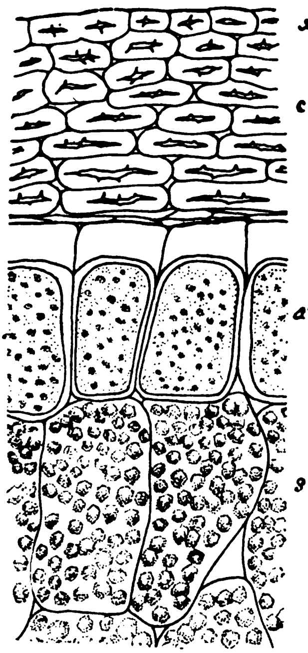


Fig. 10.
Sweet corn, Early Minnesota. *a*, epidermis; *c*, capsule and testa; *d*, aleurone layer; *s*, starch cells.

Harz l. c.

HISTOLOGY OF THE CORN LEAF.

ROBERT COMBS.

The stem bears lateral organs, the leaves. These occur at definite points, the nodes, and originate in an exogeneous manner. The leaf arises in the form of a papilla and is not covered by the superficial tissue as the root is. The mature leaf is divided into two parts, the blade and the sheath. At the base of the blade occurs the membranaceous ligule. The veins of the leaf are parallel and are continuous with those of the sheath. The vascular bundles of the sheath connect with those of the stem. The function of the leaf is the preparation of food by a process known as photosynthesis. This same function is also shared by the sheath and stem, but not in nearly so marked a degree.

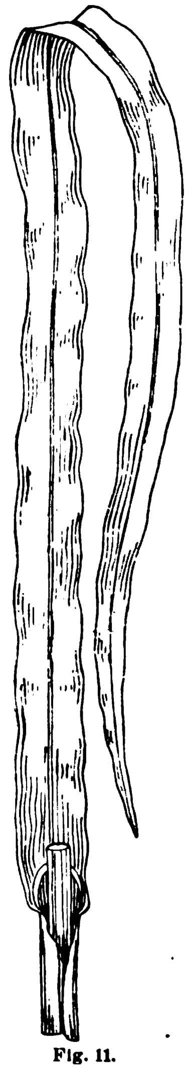


Fig. 11.
Leaf of corn showing sheath, ligule, and blade

Holm, Theodore. A study of some anatomical characters of North America Gramineæ. I. Bot. Gaz. 16: 166-171, *pl. 15*. II. 16: 219-225, *pl. 21-22*. III. 16: 275-281, *pl. 23-24*. IV. 17: 358-3.2, *pl 21*. V. 20: 362-365, *pl. 26*. VI. 21: 357-360, *pl. 27-28*. VII 22: 403-403, *pl 20*.

Sirrine, Emma, and Pammel, Emma. Some anatomical studies of the leaves of Sporobolus and Panicum. Proc. Ia Acad. Sci. 3: 148-159, *pl. 6*. 1895 (Contrib. Bot. Depart. Ia. State Coll. Agric and Mech Arts, 1: 148-159, *pl. 6*.) (Bibliography of this subject may be found in this paper.)

Sirrine, Emma. A study of the leaf anatomy of some species of the genus Bromus Proc Ia. Acad. Sci. 4: 119-125 *pl. 4-8*. (Contrib Bot. Depart. Ia. State Coll. Agric. and Mech. Arts, 4: 119-125, *pl. 4-8*.)

Pammel, Emma. A comparative study of the leaves of Lolium, Festuca, and Bromus. Proc. Ia. Acad. Sci. 4: 126-131, *pl. 9-11*. (Contrib. Bot. Depart. Ia. State Coll. Agric. and Mech. Arts, 4: 126-131, *pl 9-11*.)

Weaver, C. B An anatomical study of the leaves of some species of the genus Andropogon. Proc Ia. Acad. Sci 4: 132-137, *pl. 12-15*. (Contrib. Bot. Depart Ia. State Coll. Agric. and Mech Arts, 4: 132-137, *pl. 12-15*.)

Ball, Carleton R. An anatomical study of the leaves of Eragrostis. Proc. Ia. Acad. Sci. 4: 138-145, *pl. 16-18* (Contrib. Bot. Depart. Ia. State Coll. Agric. and Mech. Arts, 4: 138-145, *pl 16-18*)

Ogden, Miss E. L. Leaf structure of Jouvea and of Eragrostis obtusifolia. Bull. Div. Agrost. U. S. Depart. Agric. 8: 12-20. *pl 8-9*.)

The sheath in cross section shows (Plate IX), beginning at the inner or upper surface, the epidermis of large, thin-walled cells, immediately inside of which is stereome in patches, which are located opposite the large bundles on the outer side. Then comes the inner area of the sheath, made up of large, polygonal, colorless, thin-walled parenchyma cells.

The outer or lower surface of the sheath presents an entirely different aspect and varies greatly with the variety of corn. Generally speaking, it is more or less ribbed, caused by the large fibrovascular bundles. The creases have colorless unicellular hairs which are usually not developed on the epidermis over the bundles. The epidermal cells are small and thick-walled, serving together with the hairs to protect the plant against drouth and other injuries. Beneath the outer epidermis occur the bundles referred to above, usually with intervening smaller ones, but this varies with different corns. For example, a Mexican corn (No. 1) shows two sizes of bundles not connected with each other, forming no external ridges, and the epidermis shows only a few very short spur-like hairs, while a form from South America shows heavy ridges, many hairs, and only one kind of regular sized bundles.

In all cases there exists an area of stereome between the bundles and the outer epidermis.

The only chlorophyll in the sheath is located in the chlorophyll parenchyma sheath which surrounds the bundles, except a portion on the outer side which is occupied by stereome.

The leaf-blade is made up of the midrib or keel and the blade proper. On each side occur the veins with the fibrovascular bundles. A cross section of the leaf shows the keel (Plate X), on the upper or inner surface the epidermal cells are small, rather thin-walled, and immediately underlying which are several layers of stereome or sclerotic cells, which gradually increase in number, and toward the margin of the keel only occur in patches over the large bundles on the lower or outer side, and as the keel merges into the blade proper the stereome areas unite with the sheath of the large bundles. On the lower or outer surface the epidermal cells are thick-walled.

Three different kinds of bundles occur within the keel, regularly arranged as follows: The large, perfect bundles connected with the lower epidermis by a broad area of stereome, and a line of chlorophyll parenchyma down each side, but not

connected. Midway between the large bundles are small ones (Fig. 12), connected with the epidermis by a narrow, wedge-

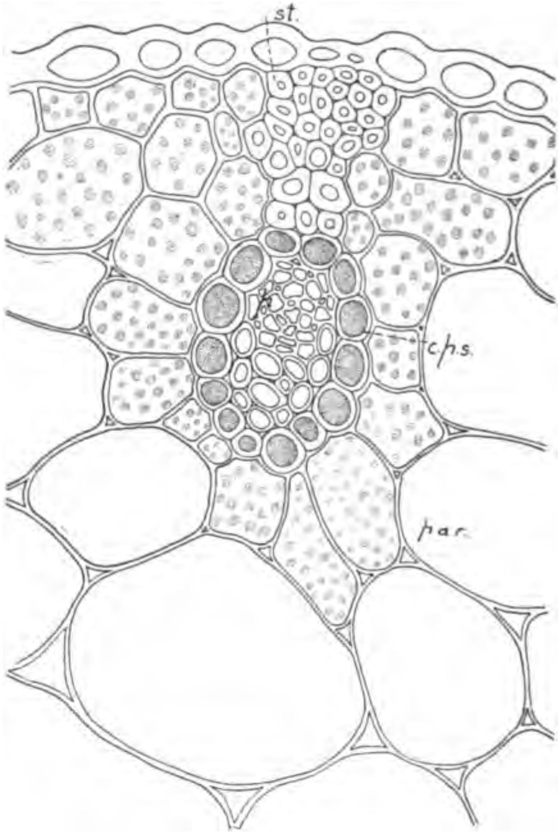


Fig. 12.
Cross section of keel, lower side, showing secondary bundle with its parts, surrounded by mesophyll, *c. p. s.*, chlorophyll parenchyma sheath; p. phloem; *st.* stereome; *par.* colorless parenchyma. (Original.)

shaped area of stereome, and almost surrounded by a thick-walled chlorophyll parenchyma sheath, and this sheath by another thin-walled one which might be called the mesophyll sheath.

Midway between each large and small bundle is usually a smaller one, isolated, and entirely surrounded by a double sheath, one of thick-walled chlorophyll parenchyma, and the second of thin-walled mesophyll. These are true mestome bundles, like those of the blade proper.

The area not occupied by stereome, between the outer epidermis and the bundles, is occupied by chlorophyll parenchyma or mestome.

Between the bundles and the upper or inner epidermis is the pith, made up of colorless parenchyma; this makes up the body of the keel.

The blade proper, in surface section of the superior or inner face (lower figure, Plate XI), shows epidermal cells irregularly rectangular in shape, with a wavy or dove-tailed outline. Between the ends of the cells is often a small, spur-shaped protuberance or hair. The long stomata are located between the ends of the cells of every third or fourth row. Their regularity in shape and arrangement is more or less interfered with along the bulliform areas. In addition to the stomata, which are moisture regulators serving also in the exchange of gases, rifts from which water exudes occur at the apex of growing corn leaves.

The bulliform areas are composed of from three to seven rows of polygonal cells with thin walls, are arranged longitudinally with the leaf, and are occasionally interrupted by or grade into the exserted cells about the base of the large hairs. These areas are usually about fourteen rows of epidermal cells from each other, and are located alternately with the veinlets. The epidermis of the lower or outer face is much the same as above, except that bulliform cells, hairs, and spur-like hairs or tubercles, are wanting and the walls are thicker.

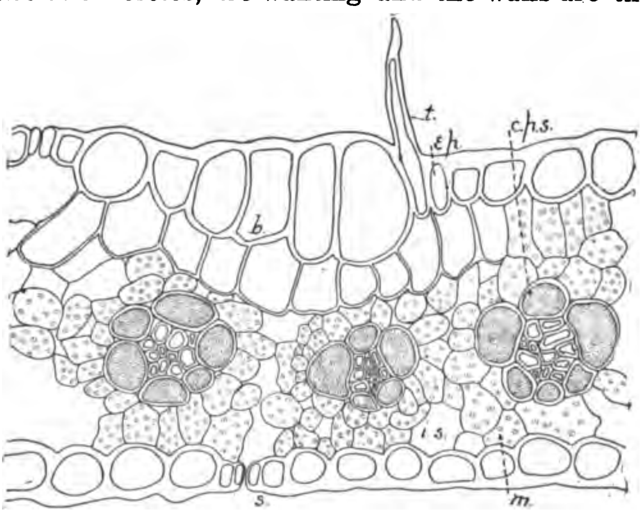


Fig. 13

Cross section of leaf blade showing: *b*, normal bulliform area with *t*, short spur-like hair; *ep.*, epidermal cells of upper surface; *c. p. s.*, cholorophyll parenchyma sheath of mestome bundle embedded in the mesophyll; *m.*, mesophyll; *i. s.*, intercellular space; *s*, stoma.

In cross section (upper figure, Plate XI), the epidermal cells of the two sides appear much alike in shape and size, the lower having a much thicker cuticle, and no hairs or b ılliform cells.

The upper or inner surface presents the bulliform cells in various forms according to the variety of corn, varying from the wedge shaped, sunken cells to those somewhat exserted and rectangular. Along each side of the bulliform area is often a row of short, spur-like hairs. The function of the bulliform cells is to fold or roll up the leaf. When there is much evaporation the water from these cells is readily given off, and the leaf rolls up, exposing only the outer or lower epidermis, which is thick and smooth, and thus reduces transpiration very materially.

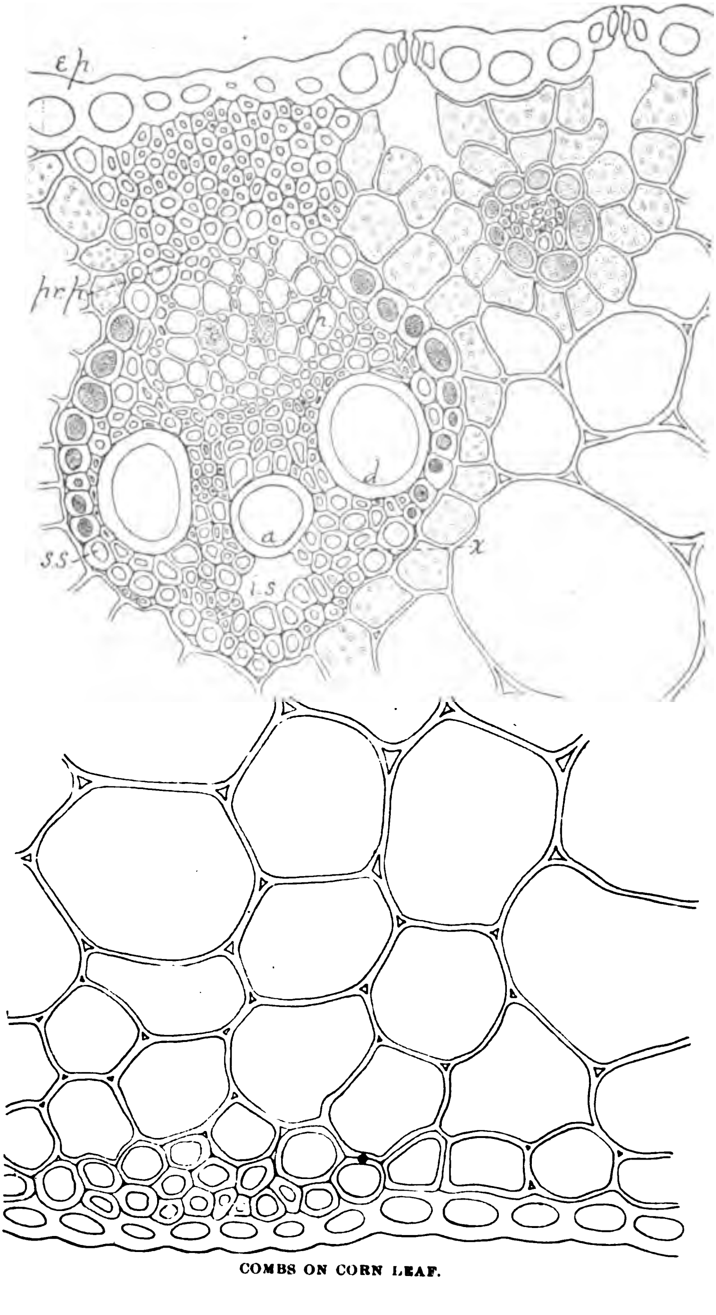
Beneath the bulliform cells is a line of colorless parenchyma. The veinlets or nerves have well developed fibrovascular bundles with areas of stereome or sclerenchyma, both above and below, which connect with the epidermis, and a line of thick-walled chlorophyll parenchyma on each side. The small mestome bundles are numerous, and about every sixth has more or less stereome between it and the epidermis, mostly on the lower or outer side. The other mestome bundles vary somewhat in size according to their proximity to bulliform cells. They are completely surrounded by the thick walled chlorophyll parenchyma sheath, and the mesophyll sheath also, but those connected with the epidermis are only partly surrounded.

EXPLANATION OF PLATES.

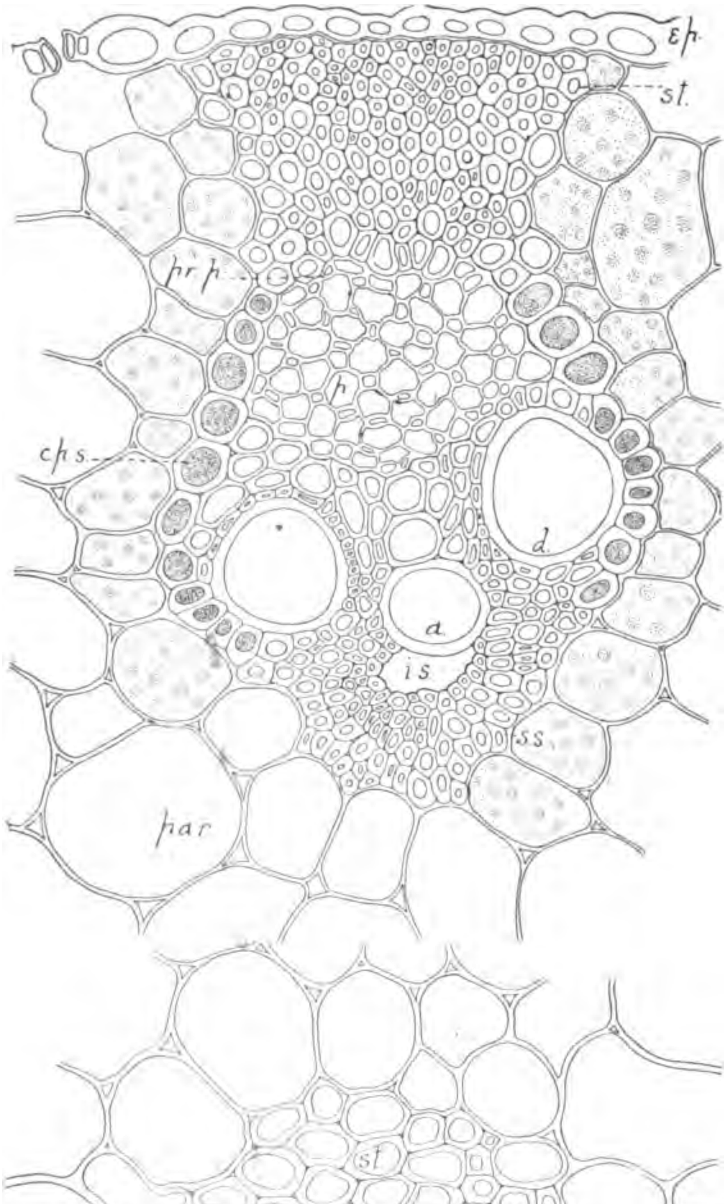
PLATE IX. Cross section of corn leaf sheath showing fibrovascular bundle, the most common, type *ep*, outer or lower epidermis; *st*, stereome; *prp*, protophloem; *p*, phloem, *c. p. s.*, chlorophyll parenchyma sheath; *d*, pitted ducts; *a*, annular ducts; *i. s.*, intercellular space; *s. s.*, sclerotic sheath; *par.*, colorless parenchyma; *i ep*, inner epidermis.

PLATE X. Cross section of keel showing large fibrovascular bundle with a mestome bundle to the right. (See Fig. 12 for small bundle) *Ep*, lower epidermis; *prp*, protophloem; *d*, pitted ducts; *a*, annular duct; *i. s.*, intercellular space; *s. s.*, sclerotic sheath; *x*, xylem.

PLATE XI. *Upper fig.* Cross section of the leaf blade of corn. *Ep*, upper epidermis. *b*, bulliform area surrounding the base of a hair; *c. p.*, colorless parenchyma; *s. s.*, sclerotic sheath (chlorophyll bearing) of the mestome bundles; *par*, parenchyma *Lower fig.* Upper surface section of epidermis; *b*, bulliform area; *ep*, epidermal cells; *sto*, stomata.



COMBS ON CORN LEAF.



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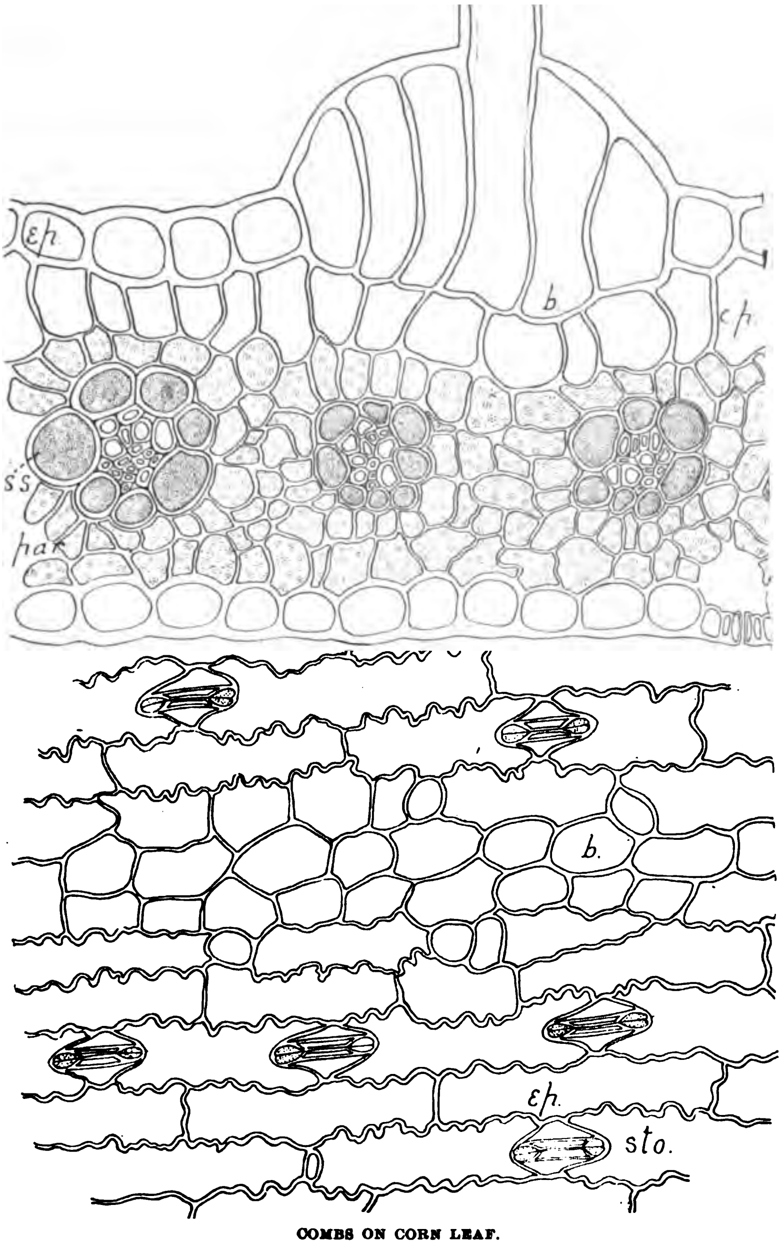


COMBS ON CORN LEAF.

SOME STUDIES ON THE SEEDS AND FRUITS OF BERBERIDACEÆ.

BY L. H. PAMMEL, J. R. BURNIP AND HANNAH THOMAS.

Although several papers bearing on the anatomy of different organs of plants of this order have been published,[1] no one has studied the comparative anatomy of the seeds.

It gives us great pleasure to acknowledge the kindness shown us by Drs. B. L. Robinson, J. K. Small, Mr. G. H. Hicks, and Prof. C. S. Sargent for favors shown us in the way of obtaining material for study and the determination of some species; the free access to and use of the library of the Missouri Botanical garden, through the courtesy of the director, Dr. Trelease, and, finally, the faithful work in drawing the seeds and fruits and preparing the microscopic details for the engraver by Miss Charlotte M. King.

The literature on the anatomy of seeds is somewhat meager. Godfrin[2] (1880) has given us an account of *Berberis sinensis* and *B aquifolium.* He states that the testa in this family are much alike. His figure and description of the osteosclerid layer does not agree as we have found it in the species studied.

He gives us a very good account and figure of the epidermal cells of *B. aquifolium* He speaks of the epidermal cell-walls

1 Decaisne, J. Memoire sur la famille des Lardizabalées précidé de remarques sur l'anatomie comparée de quelque tiges de végétaux dicotylédonés. Arch. Mus. Hist. Nat Paris. 1:143-213. *pl. 10-13.* Separate 1839.

Le Maout and Decaisne, J. Traité generalé de botanique descriptive et analytique Paris, 375. 1868.

Baillon, H. Remarques sur l'crganization des Berberidées. Adansonia 2:268—Histoire d pl. 3:43-76

Prantl, H. Berberidaceae in Engler and Prantl, Die natuerlichen Pflanzenfamilien 3: 70-77.

Vesque. J. De l'anatomie des tissues. Nouvelles Arch. du Muséum II. 4:48-51.

Van Tieghem, Ph. E. Recherches sur la structure du pistil et sur l'anatomie comparée de la fleur. Memoires savants etrange Acad. Paris. 21:1-261. Separate 35. *pl. 2, f. 47-50.* 1871.

2 Etude histologique sur les téguments seminaux d. angiospermes. Bull. Soc. d. Sci. d. Nancy 5: 188-189, *pl. 4. f. 9-10.*

as being slightly lignified. The epidermal cell-walls in *B. amurensis* and *B. Thunbergii* studied by us are not lignified. Brandza[3] (1891) also speaks of a lignification of the cell-walls of the epidermis in *B. sinensis*

His figure and description indicate that the osteosclerids are round. This layer, according to his researches on the development, forms a part of the outer integument. The pigment layer to the inner integument. He found tannin in the pigment layer in this species and *B. aquifolium.*

Brandza also studied the development of *Epimedium sulphureum.* Otto Paul[4] (1882) describes the endosperm of *B. emarginata,* noting that the cell-walls may be differentiated into three parts, and that the contents consists of fat and protein.

W. Hirsch[5] (1890) has given an excellent account of *B. vulgaris,* in which he notes that the cells of the lower part of the endosperm rapidly absorb water, swell, and finally collapse. These cells transfer nutrient material to the embryo during germination, and also gives it more space so that it can expand.

J. Holfert[6] (1890) studied the seeds of the same species with special reference to the nutrient layer, but he also studied other parts of the testa. He distinguishes six layers as follows: (1) Epidermal cells strongly cuticularized; (2) a single row of parenchyma cells, the walls becoming mucilaginous; (3) nutrient layer; (4) osteosclerids correctly figured and described; (5) obliterated nutrient layer, or pigment layer; (6) several rowed nutrient layer with colorless cell-walls.

Marloth[7] (1883) recognized four layers, the two inner consisting of cells with delicate walls. He also describes the epidermal cells, and the somewhat thick-walled parenchyma cells. *Berberis* is classed in his fourth group, in which the protective features occur in the testa, endosperm abundant, but cell-walls not thickened. John Lubbock[8] figures and describes the seeds of several of our species. The seeds of *B.*

3Développement des teguments de la graine. Revue generale de Bot. 3: 76-78. *pl. 5, f. 1-4.*

4Vergleichende Untersuchungen über das Endosperm Inaug. Dis. Goettingen 27.

5 Untersuchungen ueber die Frage welche Einrichtungen bestehen behufs Ueberführunig d. in dem Speichergewebe d. Samen niedergelegten Reservestoffe in d. Embryo b. d. Kei Diss Inaug. Dis. Erlangen.

6 Die Nährschicht d. Samenschalen. Inaug. Dis. Erlangen Flora. 4: 1890. Marburg 26. *pl. f. 10-11.*

7Ueber mechanische Schuetzmittel d. Samen gegen schädliche Einflüsse von aussen. Engler Bot. Jahrb. 4:225-264.

8 A Contribution to Our Knowledge of Seedlings. London. 1:103-114. *f. 142-144.*

aquifolium and *B. vuglaris* are figured in a general way. *B. erecta*, *B concinna*, *B. sibirica.* as well as *Podophyllum emodi*, are described.

Brandza, who studied the development of *Berberis* and *Epimedium*, considers that the testa consists of two integuments. The epidermal layer, the outer nutrient layer and osteosclerids belong to the outer integument; the pigment layer and the collapsed parenchyma cells belong to the inner integument.

Some excellent details of development are given by Dr. Gray[9] in his genera of North American plants.

In matters of synonomy and arrangement we have followed Gray and Robinson[10] so far as it relates to American species.

BERBERIS CANADENSIS *Pursh.*[11]

Fruit and Seed Characters.—Berry short-oval or sometimes globular, scarlet, two to three lines long, small, loose racemes, one to several seeded. Seeds oblong, shining, two lines long, obtusely three-sided, raphe on obtuse inner angle, chalaza at tip, micropyle and hilum adjacent, hilar pit with rounded, thickened border

Epidermis.—Cells elongated, slightly irregular on the margin, cuticle of uniform thickness, sharply demarcated from the remainder of the cell wall. The cuticularized layer is thicker and lighter in color, layer within uniform in thickness except where "cones" project into the lateral walls. The layer within cuticularized portion is brown in color, uniform in thickness. The walls are marked by conspicuous pore canals. The internal narrow zone is lighter in color than the outer part. This wall forms the separating line of adjoining cells and contains pore canals. The cells contain some coloring matter and protein substances, the latter being always reduced to a minimum, also an abundance of tannin.

Nutrient layer.—The cells are large and somewhat irregular, walls are brown, the cavity brown, containing a large amount of pigment and some protein matter. This layer may be separated into two parts. In the lower portion the cells are compressed and thick-walled. Tannin also occurs in this portion of the nutrient layer.

Osteosclerid.—Consists of one layer of cells, broad at the upper end, where the walls of adjoining cells usually unite;

9 The Genera of the Plants of the United States. 1:77-90. *pl. 31-36*

10 Synoptical Flora of North America. 1:66-72.

11 Gray. The Genera of the Plants of the United States 1: 79. *pl. 31, f. 10-12.*

the cell cavity is very much reduced; has triangular intercellular spaces where the walls are united. Cells contain some brown pigment.

Pigment layer.—This layer belongs to the inner integument, and consists of narrow, thick-walled, elongated cells much darker in color than cells of nutrient and osteosclerid layers.

Parenchyma layer.—The cells of this layer are much compressed, and can only be made out on the addition of chloral hydrate. The cells are thin-walled and variable as to shape in different portions of the seed.

Endosperm.—The cells of endosperm are much alike, the first layer, aleurone, somewhat smaller, walls greatly thickened with longitudinal striæ; the cells contain no starch, but an abundance of protein and fat. A narrow zone of endosperm next to the embryo consists of thick-walled, elongated cells. The cell cavity in most cases being reduced to a narrow line.

Embryo.—The cells are quite uniform as to size, nearly isodiametric, cell walls thinner than in endosperm, densely packed with fat and protein grains. Procambial bundles in central part of the caulicle.

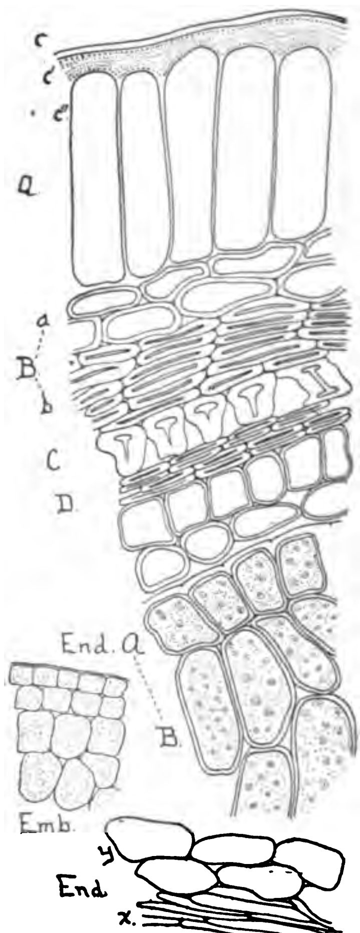


Fig. 14 Berberis amurensis, for description see explanation of plates.

BERBERIS AMURENSIS *Rupr.*

Fruit and seed characters. — Berry light scarlet, in loose racemes, ellipsoidal, 4–5 lines long, usually two seeded. Seeds oblong-obovoid, light brown, obtusely two or more sided, convex on one side, and more or less flattened on the other; the raphe extending along one edge of the flattened side, chalaza at the apex. Seeds brown, three lines long, hilum and micropyle adjacent, the former a depressed cavity with a raised border.

Epidermis.—The palisade-like epidermal cells with thickened exterior walls, the latter much thinner; occasionally with thin cross-walls so that the epidermal layer consists of two layers. The cuticle of uniform thickness, the cuticularized layer strongly developed, lighter in color than cellulose layers. But all of the walls carry more or less pigment, with an abundance of tannin.

Nutrient layer.—This consists of two portions, the cells of upper part larger and thinner than lower. In ripe seed very much compressed, but can be made out readily by treating with chloral hydrate. Cells contain pigment, tannin, and protein grains, though the latter are not abundant.

Osteosclerid.—This consists of a single row of cells and does not differ essentially from that of *B. canadensis.* The cell-walls are much lighter in color than the pigment layer, and with a small cell cavity; in some cases the cells are not triangular in shape, but I-shaped, as in many leguminous seeds.

Pigment layer.—Cells elongated, thick walled, two or more rows. The walls, colored dark brown, when treated with ferric chloride show an abundance of tannin.

Endosperm.—The bulk of the endosperm consists of thick-walled cells which color blue with chloride of zinc, consisting of cellulose. The lower part of endosperm consists of smaller elongated cells. As stated by Hirsch, these cells collapse readily, and not only serve to convey nutrient material to the growing embryo, but to make room for its expansion. The aleurone layer does not differ essentially from most of the cells of endosperm, except that the cells are somewhat smaller. Cells contain fat and protein grains.

Embryo—The cells of first row with thick walls uniform in size, those below larger and irregular in shape. Cells contain fat and protein cell-walls and starch. Tannin absent.

BERBERIS VULGARIS *L.*[12]

Fruit and seed characters.—Baccate fruit, born in a loose raceme, scarlet, four to five lines long, two to three seeded; seeds light brown, ovate, two to three sided, two to two and one-half lines long; testa minutely roughened; hilum and micropyle in lower narrow end; the hilum forms a depressed round cavity with a raised border.

12 { Holfert. [26]. Hirsch, [19].

Epidermis —Palisade-like cells elongated, larger than in *B. canadensis*, occasionally divided. The cuticle of uniform thickness. The cuticularized layer somewhat undulating, lighter in color than cuticle, somewhat thicker than cellulose layers. The cuticle is darker in color than cuticularized portion. The internal layer of cell-wall is narrow and brown. Cells mostly empty except the pigment and a few protein grains.

Nutrient layer.—This is made up of two parts. The cells of the upper are somewhat irregular, comparatively thin-walled. Cells in lower part elongated, thicker-walled. Cell-walls contain a brown pigment. Vascular elements carried in this layer. These color rose on the addition of phlorglucin and hydrochloric acid.

Osteosclerid.—This consists of a single layer of thick-walled cells, with a large triangular intercellular space below, owing to the occurrence of a cell with a large diameter above and a narrower one below. Cell-walls nearly colorless.

Pigment layer.—Cells elongated, thick-walled, one to two rows of cells. Walls colored brown. Some pigment also contained in cell cavity.

Parenchyma layer —Just below the pigment layer occur thin-walled cells variable in size. This layer is very granular, and contains much more protein than occurs in nutrient layer. Holfert also classes this as a nutrient layer.

Endosperm.—The greater part of the seed is made up of endosperm. Cells of first row somewhat smaller. Walls uniformly thickened, differentiated into three parts. The bulk of the endosperm consists of cells larger than aleurone The internal part of the endosperm with smaller elongated cells. Cells contain fat and protein grains

Embryo —The cells of this layer do not differ essentially from those of *B. canadensis* and *B amurensis.*

BERBERIS THUNBERGII *DC.*

Fruit and seed characters.—Fruit baccate, bright orange-scarlet, oval or elliptical, four to five lines long, one-seeded. Seeds terete, four lines long, nearly obovate; testa shining dark brown, terete in outline, minutely pitted; micropyle and hilum basal and adjacent, with a thickened margin.

Epidermis.—Cells large, somewhat longer than broad, variable as to size; internal walls thin, outer wall thickened; composed of four parts, the outer cuticle well developed; the cuti

cularized portion below is narrow, of even thickness; the intermediate layer is thicker and stratified, but not so much as in *B. nervosa*. The internal walls are much thicker than in *B. vulgaris*. Cells and walls carry a large amount of pigment. The cells contain some protein matter.

Nutrient layer.—First row of cells irregular, large, rather thick-walled. Cells below longer with walls of about the same thickness; this layer contains the vascular elements; on the addition of phlorglucin and hydrochloric acid the walls of these elements color rose purple. In addition to these layers another occurs, the cells of this are much smaller than in the preceding, not elongated radially, walls irregularly thickened and brown.

Osteosclerid.—Consists of a single layer of cells. Walls much thickened with a large triangular space. Cell-cavity very small. Cell-walls colored brown.

Pigment layer.—This consists of a narrow zone of one or two rows of cells, greatly elongated, with thick walls, deeply dark brown colored.

Parenchyma layer.—Occurs below the pigment layer, and is composed of three or four rows of cells. This layer is much compressed. In most cases cells contain granular protein grains.

Endosperm.—First row, the aleurone layer of smaller cells than remainder of endosperm, filled with protein grains and fat. In some cases a few tannin and pigment cells occur. It is very unusual for endosperm to contain pigment. The cell-walls of remainder of endosperm thick-walled. The walls color blue with iodine and sulphuric acid, and chlorodide of zinc. The internal part of endosperm consists of thick-walled elongated narrow cells.

Embryo.—First row of cells smaller. The exterior walls thickened. All these cells contain fat and protein grains but no starch. The walls consist of cellulose. Rudimentary bundles also occur in the caulicle, but lignification has not taken place

BERBERIS CERASINA *Schrader?*

Fruit and seed characters.—Baccate fruit, bluish-scarlet, globular, borne in a long and loose raceme; berry ten lines long, one or two-seeded. Seed brown, shining, five lines long, terete or one side flattened, the other convex; micropyle and hilum adjacent;

[illegible] border. Micro-
[illegible] from *B. vulgaris*
[illegible] across the mid-
[illegible]

[illegible] The osteosclerid
[illegible] intercellular

[illegible] narrow zone of
[illegible] two parts: the
[illegible] of embryo
[illegible]

[illegible]

[illegible] in rather
[illegible] purple or blue,
[illegible] seed oblong-
[illegible] pale brown
[illegible] adjacent. The
[illegible] The raphe
[illegible] at the apex.
[illegible] Cuticle well
[illegible] layer of cell-wall
[illegible] This pro-
[illegible] thickened third
[illegible] thickened.
[illegible] stratifica-
[illegible] narrow. The
[illegible] greatest length
[illegible] it has thinner
[illegible] of the cell-wall,
[illegible] characterize this
species [illegible] *Echium*.

Palisade [illegible] several rows of cells, those
of the first [illegible] larger than the succeed-
ing. [illegible] The cells in lower portion elon-
gated, [illegible] considerable pigment.

Osteosclerid.—[illegible] differ essentially from those
previously described. [illegible] of a single row of cells with
greatly thickened walls and a small cell cavity, and the char-
acteristic intercellular space.

Pigment layer—Several rows of much compressed, thick-walled, elongated cells of darker color than the nutrient layer.

Parenchyma layer.—Much compressed cells with granular contents of protein grains, somewhat variable in thickness.

Endosperm.—This constitutes the bulk of the seed; the first row of cells does not differ essentially from those beneath, except that they are somewhat smaller. In the lower portion of endosperm, the cells are smaller, elongated, and thinner-walled. The thick walls of the endosperm cells are differentiated into three parts, the inner being much more strongly developed. On the addition of sulphuric acid and iodine, the walls color blue The cells do not contain starch, but protein grains and fat.

Embryo.—Does not differ from other species studied.

BERBERIS REPENS *Lindl.*

Baccate fruit in a comparatively short raceme, blue with a glaucous bloom, four to five lines long, five or more seeded. Seeds dark brown, ovate, elliptical or quadrangular, curved at base, two lines long, two or more sided, obtuse or somewhat angular; dorsal side convex. Testa minutely roughened, prominent raphe on one side, chalaza at the tip. Micropyle and hilum adjacent, hilar pit small with a well marked border.

Epidermis.—This species does not differ from the preceding. The cuticle is well developed. The remainder of cell-wall enormously thickened; the third layer of wall shows prominent stratification; the cell-cavity is much reduced, the walls colored brown.

Nutrient layer.—This layer seems to be suppressed in some places. The cells are not so regular as in other species. In some cases they are more elongated, in others are the characteristic triangular intercellular spaces; the cell-cavity in this species is larger than in other species of the sub-genus. The epidermal cells are much longer, and as regards stratification, it has reached its highest development in this species. It would not be difficult to separate this species from the other members of this sub-genus by the characters here presented.

Pigment layer.—Cells narrow, elongated, thick-walled, brown. An abundance of tannin.

Parenchyma layer.—A much compressed layer. Cells carrying a large amount of granular matter, consisting mostly of protein grains.

Endosperm.—This does not differ from preceding species, as to shape, size and contents of cells.

Embryo.—Agrees with *B. aquifolium.*

B. NERVOSA *Pursh.*

Fruit and seed characters.—Baccate fruit, borne in a long raceme, blue with glaucous bloom, globular three to four lines long, one to two seeded. Seeds brown, oblong, curved at base, two lines long, two-sided or terete; raphe extends along the edge of the narrow side, prominent. Testa shining, slightly pitted, chalaza at tip of seed, hilum and micropyle adjacent. The hilar pit smaller than in *B. Thunbergii.*

Epidermis.—The cuticle well developed, forming a continuous zone on the outer surface, followed by a straw-colored stratified layer, which reaches its greatest thickness where the walls separate, giving this portion a concave appearance. The third layer is also strongly stratified, darker in color and decidedly uneven, presenting the appearance of a series of cone-shaped depressions, around which the lines curve. A narrow connection occurs between this and the middle portion of cells, where the wall is thicker than below. This again connects with a thickening in lower part of wall. The internal part of wall is lighter in color and strongly stratified; walls are greatly thickened, with a small cell-cavity. The cells are lighter in color than in nutrient and pigment layers.

Nutrient layer.—Structure same as in last species. Cell-walls much darker in color in lower part of parenchyma.

Parenchyma layer.—This layer is much compressed, and consists of thin-walled cells. In some places poorly defined. Cells contain protein grains.

Endosperm.—First layer of cells smaller, with thickened outer walls, cells below larger except a narrow zone next to the embryo; the latter are elongated, thick walled, and contain but a small amount of granular matter. The cells of endosperm contain no starch, but an abundance of fat and protein grains. Cell-walls made up of cellulose.

Embryo.—First row of cells regular, somewhat longer than broad, with thickened outer walls, much smaller than those below, filled with protein grains and fat, but no starch.

CAULOPHYLLUM THALICTROIDES *Michx.*

Fruit and seed characters.—Dr. Gray[13] long ago called attention to the disappearance of the thin pericarp soon after fertilization owing to the pressure of the growing seed. The ovary contains two stalked ovules Seeds at maturity three lines long, stalked, globular, blue, covered with a glaucous bloom, four lines in diameter. The bony inner part of the testa dark brown, hard, with a conspicuous white horny endosperm.

Epidermis.—Cells somewhat longer than broad, thick-walled, brown. The cuticle even, cuticularized layer thicker than internal layer. Cell cavity much reduced.

Nutrient layer.—Variable in thickness. This is followed by thick-walled parenchyma cells; containing more pigment than the parenchyma cells. The osteosclerid layer absent.

Nucellar layer—This is very much reduced and compreseed. The cells contain a large amount of protein in the shape of small grains.

Endosperm.—The bulk of the seed consists of endosperm. The cells are very thick-walled, and on the addition of water, swell. The cells of internal part of endosperm are elongated, smaller and thicker walled.

JEFFERSONIA BINATA *Barton.*

Fruit stipitate, coriaceous, obovate, dehiscent by a slit at the top, with a persistent short style, seven lines long. Seeds numerous, slightly curved, oblong arillate laterally, three lines long. Testa brown, shining, longitudinally wrinkled. Hilum in a depressed cavity on outer side the persistent straw-colored arillus.

Epidermis.—The cells are rather short, exterior wall greatly thickened, the cuticle covering the surface evenly, darker in color than the cuticularized layer. The internal wall narrower and arched above. Cell cavity considerably reduced.

Nutrient layer.—This is more strongly developed than in *Caulophyllum* or *Diphylleia*, consists usually of about six rows of cells. The first layer of cells does not differ materially from those below. The walls show peculiar thickenings in the angles; resembling the mechanical element collenchyma found in different plants. Walls colored brown.

13 The Genera of the Plants of the United States. 81. *pl.* 32.

Osteosclerid.—The cells of this are thick-walled and have the shape of an I, like the cells of the second layer in the testa of leguminous seeds. The narrow parts meet below, allowing an intercellular space between the projecting arms. These cells are much smaller than those of *Berberis.*

Pigment layer.—This consists of short, thick-walled cells radially elongated, carrying more pigment than the cells of the parencnyma layer.

Parenchyma layer.—Not strongly developed and varies in thickness in difier nt parts of the seed. The cells are elongated, but somewhat irregular; contain protein grains.

Endosperm.—This makes up the bulk of the seed, is a pure, white, hard substance. Cell-walls greatly thickened, differentiated into three well-defined portions. The cells contain fat and protein grains, but no starch. The first layer of cells of endosperm does not differ materially from the remainder. There is, however, a slight difference in the cells of the endosperm next to the embryo; these are smaller and radially elongated.

DIPHYLLEIA CYMOSA *Michx.*

Fruit and seed characters—Baccate fruit blue, four to six lines long. by four to five lines oblong or globose, usually two-seeded. Seeds oblong, curved at the base, usually two-sided. Testa reddish, wrinkled. Hilum with a white scar, in a somewhat depressed cavity, and a conspicuous tubercle towards the dorsal side.

Epidermis.—The epidermal cells are rather short, in some cases elongated, and in others isodiametric. The cuticle well developed, and as in *Berberis* the wall is differentiated into three parts. The portion below the cuticle is thicker and lighter in color. The middle portion of the wall is irregularly thickened, producing cone-like projections between the lateral walls. The internal wall is somewhat brownish and strongly stratified.

Nutrient layer.—The cells of this layer are thinner-walled, considerably elongated; the layer is variable in thickness, consisting of three or four rows of cells.

Osteosclerid.—This layer so characteristic in the *Berberis*, does not appear in this genus.

Pigment layer.—This is but slightly differentiated.

Endosperm.—Well developed. differentiated into two parts. The first row of cells, aleurone, next to the testa, does not

differ materially from the remainder, except that the cells are somewhat smaller. The cell-walls of endosperm are thick-walled, usually somewhat longer than broad, first row of cells uniform. Cell walls colorless, consist of cellulose. Cell contains fat and protein grains.

PODOPHYLLUM PELTATUM *L.*[14]

Fruit large, ovate; a fleshy berry. Seed white, enveloped by a pulpy arillus, which on drying becomes membranaceous. Some writers do not admit that this is a true arillus. Seeds elongated, three by one and three-fourths lines long, white. The upper end of the seed larger than the lower, somewhat irregular.

Epidermis.—Cells much larger than in *Jeffersonia*, light colored, cuticle somewhat irregular, darker in color than cellulose layer. The inner layer arched. Cell cavity large.

Nutrient layer.—This consists of two layers of large cells, longer than broad, with thin walls. Cells contain protein grains.

Osteosclerid.—Apparently absent.

Pigment layer.—Does not differ essentially from *Jeffersonia*,

Endosperm.—Bulk of seed is made up of white endosperm. The cells of first layer, aleurone, are smaller than the remainder except that portion of the endosperm next to the embryo. The walls are thickened, white. Cells contain fat and protein grains. Cell walls made up of cellulose.

Embryo.—First row of cells smaller, and form a continuous row. The cells contain fat and protein grains, but no starch. Cell-walls made up of cellulose.

KEY BASED ON ANATOMICAL CHARACTERS.

A. Epidermal cells greatly elongated.
  1. Cell cavity of epidermal cells large.
    a. Stratification of epidermal cell-walls evident.
      B. Thunbergii, *B. amurensis*.
    b. Stratification of epidermal cell-walls not evident.
      B. canadensis, *B. vulgaris*, *B cerasifna*.
  2. Cell-cavity much reduced with very evident stratification.
      B. repens, *B. aquifolium*, *B. nervosa*.

B. Epidermal cells not greatly elongated.
  1. Epidermal cells brownish or black.
    Small, not much longer than broad, brown,
      Jeffexsonia.

14 Gray. The Genera of the Plants of the United States. *pl.* 35–36.

Longer than broad, blackish,

Cauloyhyllum.

Isodiametric, internal layer of ex'erior wall stratified, reddish,

Diphylleia.

2. Epidermal cells light colored, large.

Podophyllum.

KEY BASED ON FRUIT CHARACTERS.

A. Fruit a berry, 1, 2, 3.

1. Scarlet, acid except *B. Thunbergii*
   Short oval or globular. *B canadensis.*
   Ellipsoidal, eight to ten lines long. *B. amurensis.*
   Ellipsoidal, eight to ten lines long. *B. vuglaris.*
   Globular, bluish scarlet. *B. cerasina.*
   Oval or elliptical, bright scarlet *B Thunbergii.*
2. Blue, or bluish-black with glaucous bloom.
   a. Short.
   Ovate or elliptical, eight to ten lines long.
   B. aquifolium.
   Eight to ten lines long.
   B. repens.
   b. Long.
   Fruit globular, few seeded.
   B. nervosa.
   Fruit globular, in a corymbiform cyme.
   Diphylleia cymosa.
3. Fruit a large, fleshy berry, borne singly.
   Podophyllum peltatum.

B. Fruit a pod.
   Jeffersonia binata.

C. Pericarp deciduous.
   Caulophyllum thalictroides.

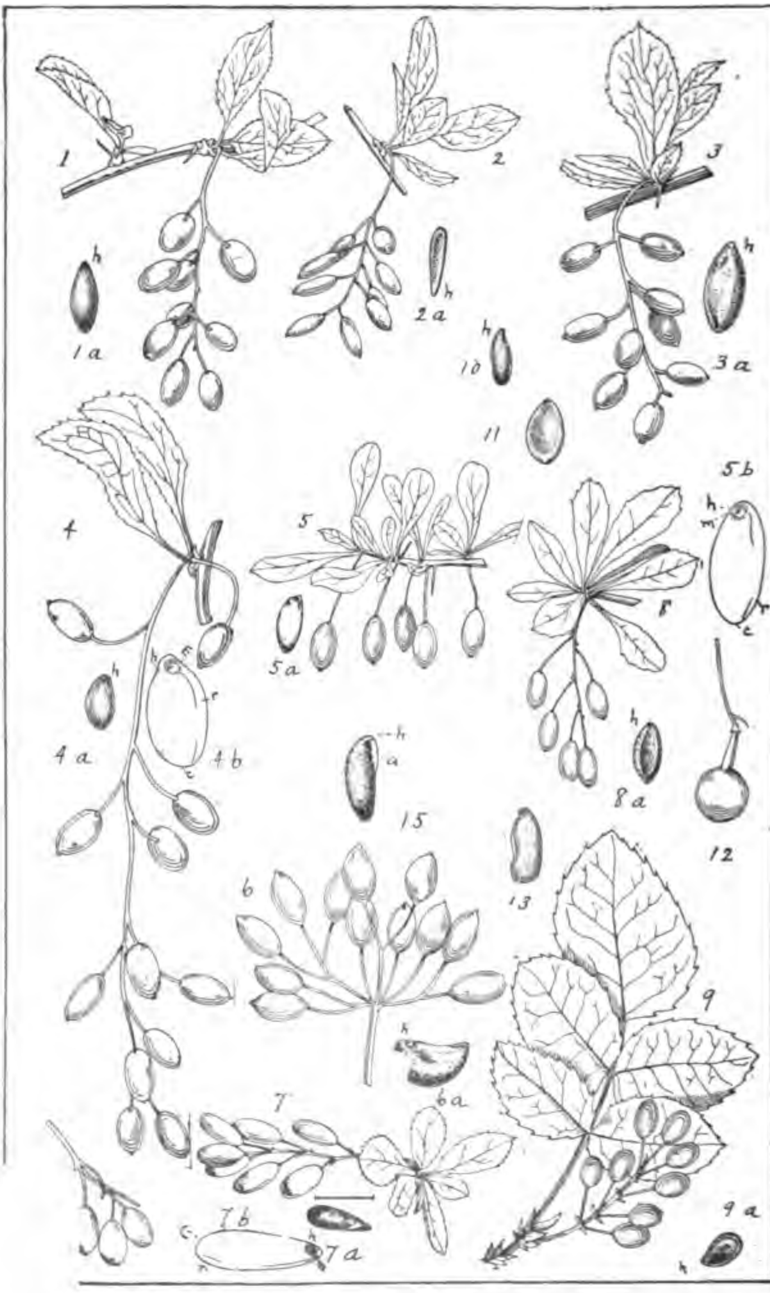
KEY BASED ON SEED CHARACTERS.

A. Seeds arillate.

1. Whole seed enveloped by a pulpy arillus.
   Podophyllum peltatum.
2. Small lateral aril at base.
   Jeffersonia binata.

B. Seeds not arillata, 1, 2.

1. Seeds globose, blue, berry-like.
   Caulophyllum thalictroides.
   a. Hilum of same color as seed.
   (1) Seeds usually terete, large, obovate.
   B. Thunbergii.
   Seeds usually terete or convex dorsally.
   B. cerasina.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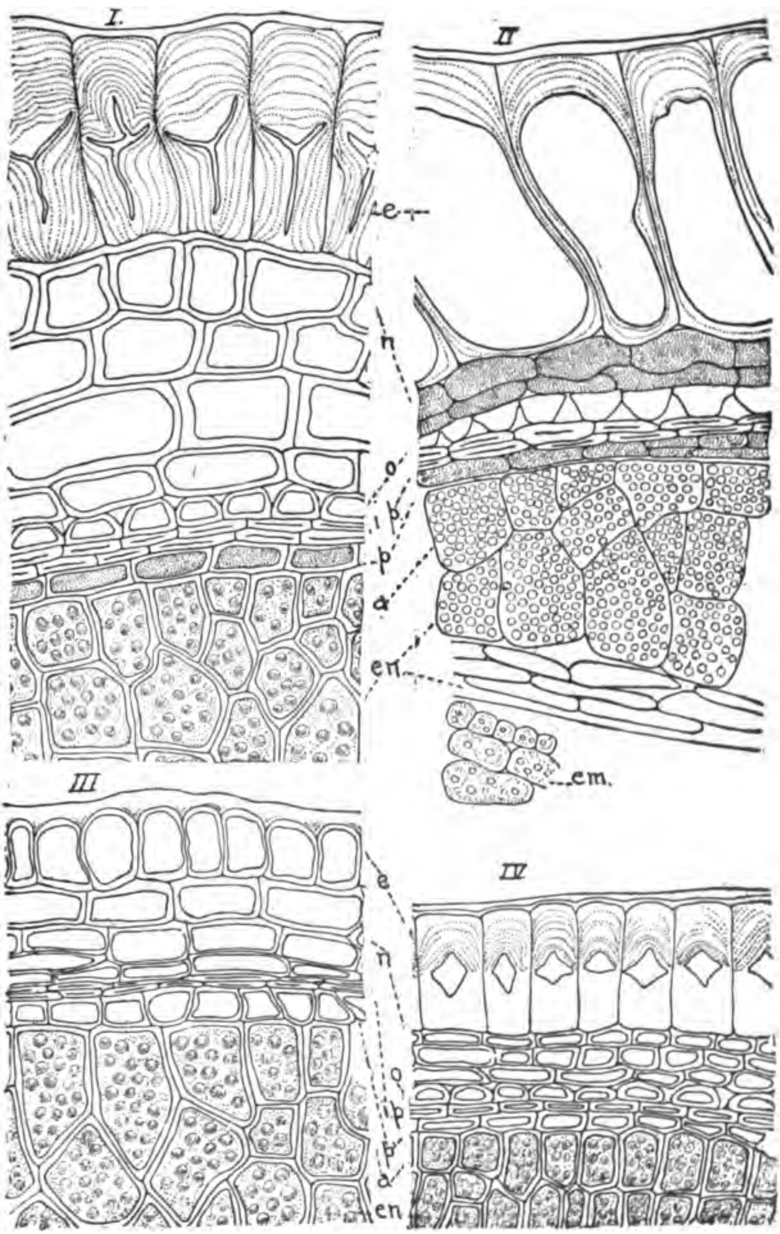
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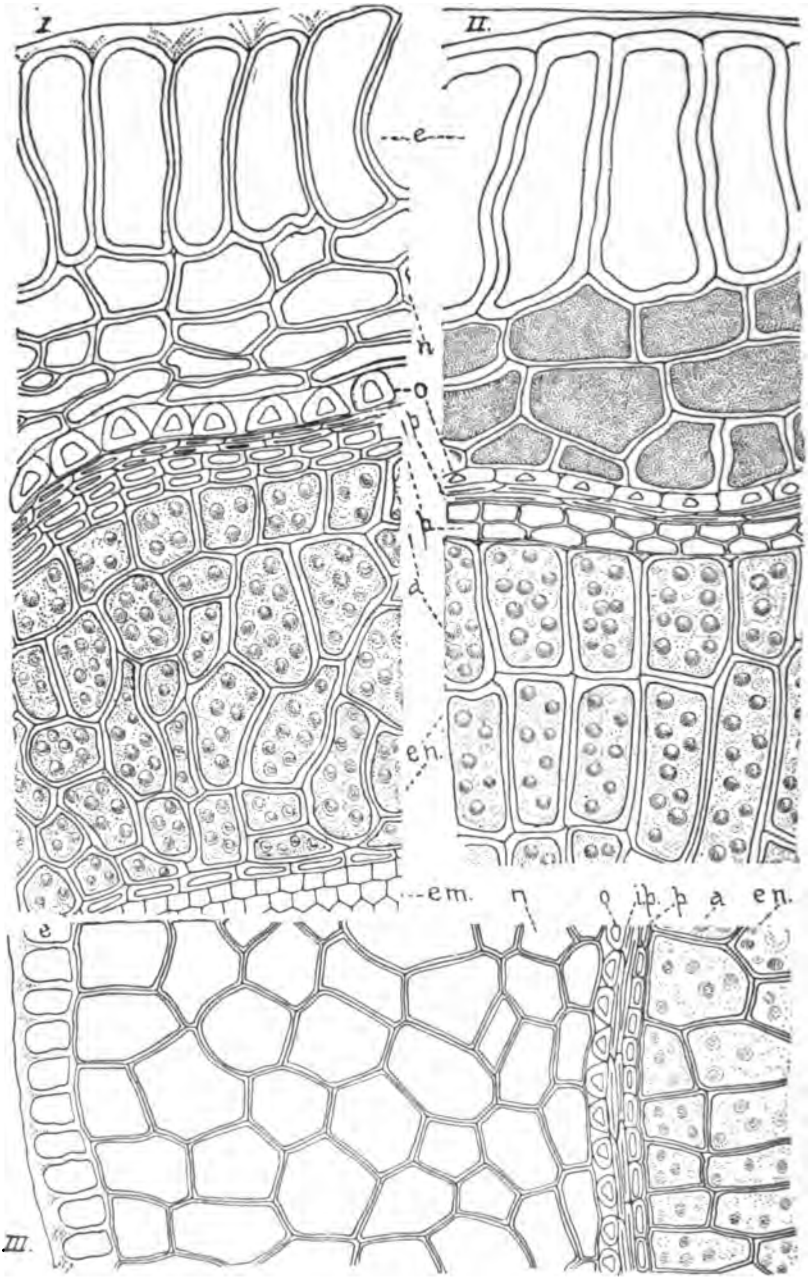
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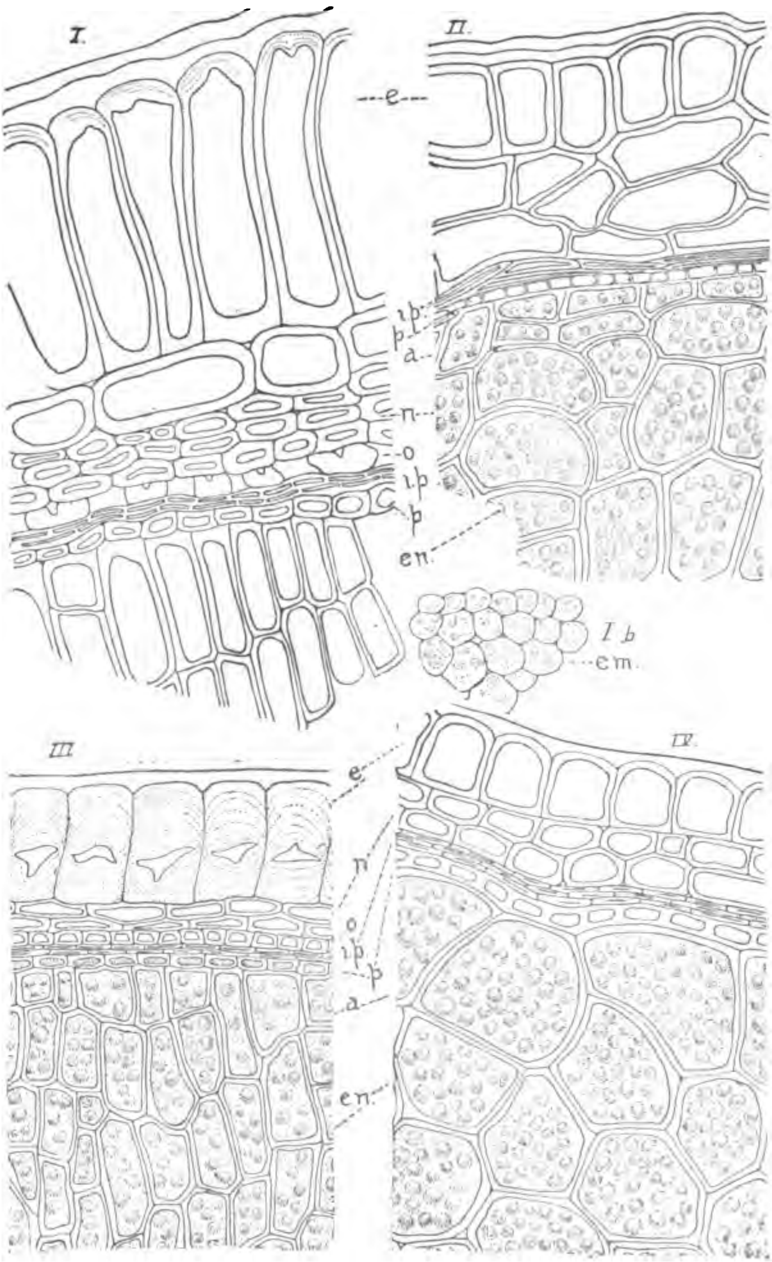
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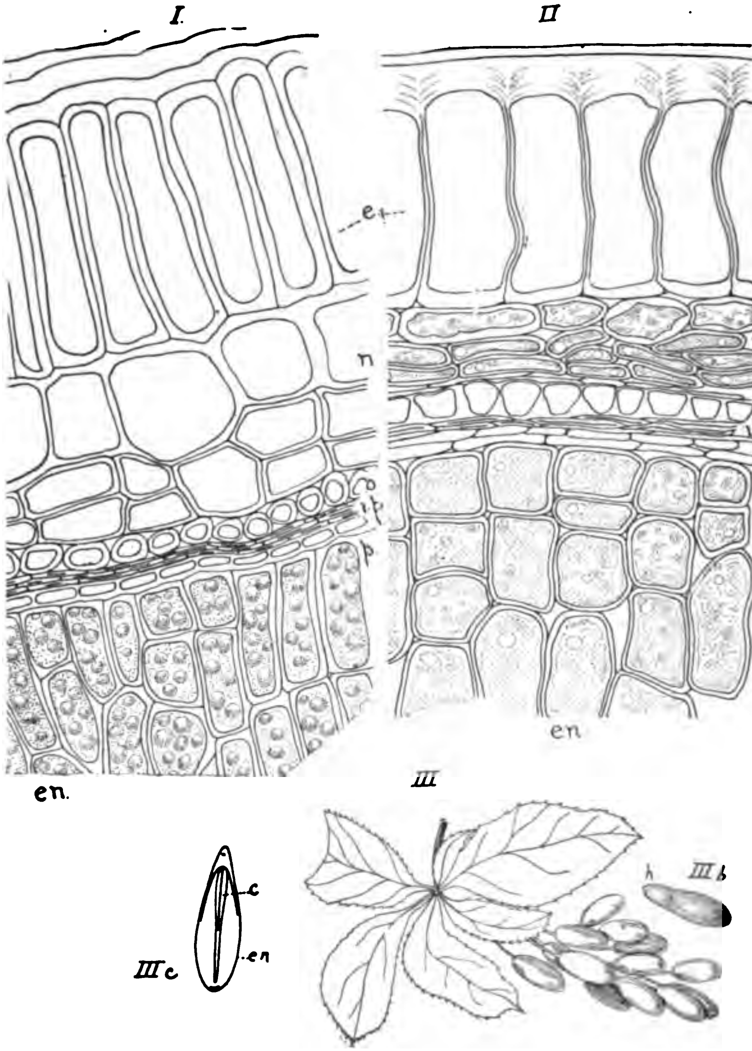
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(2) Seeds not terete.

Shining, oblong, four lines long.

B. canadensis.

Light brown, oblong, three lines long.

B. amurensis

Light brown, ovate, four to five lines long.

B. vulgaris.

Light brown, obovoid, ten lines long.

B. aquifolium.

Dark brown, oblong, curved, four to five lines long, small.

B. repens.

Brown oblong, curved at base, four lines long, large.

B. nervosa.

b. Seeds reddish, hilum white.

Diphylleia cymosa.

EXPLANATION OF PLATES.

Abbreviations used for different parts of seed: *e*, epidermal cell; *n*, nutrient layer; *o*, osteosclerid layer; *p*, pigment layer; *a*, aleurone layer; *en*, endosperm; *ip*, inner integument; *em*, embryo,

PLATE XII Fig. 1. Berberis laxiflora B. canadensis; *1a*, seed; *h*, hilum. Fig. 2. B. esculenta, (Hort.). Fig. 3. Form of B. cerasina. Fig. 4. B. cerasina. Fig. 5. B. thunbergii; *5a*, seed; *5b*, seed; *h*, hilum; *r*. raphe; *c*, cotyledons. Fig. 6 Diphylleia cymosa. Fig. 7. B. vulgaris; *7a*, seed; *7b*, seed; *r*, raphe; *m*, micropyle; h, hilum, Fig. 8. B. amurensis. Fig. 9. B. aquifolia. Fig. 10. B. repens. Fig. 11. B. nervosa. Fig. 12. Caulophyllum thalictroides. Fig. 13. Podophyllum peltatum. Fig. 14. B. canadensis. Fig. 15. Jeffersonia binata; *a*, arel; *h*, hilum.

PLATE XIII. Fig. I. Berberis nervosa. Fig. II. Form of *B. cerasina.* Fig. III. Podophyllum peltatum. Fig. IV. B. repens.

PLATE XIV. Fig. I. B. canadensis. Fig. II. B. thunbergii. Fig. III. Jeffersonia binata.

PLATE XV. Fig. I. B. vulgaris. Fig. II. Diphylleia cymosa. Fig. III. B. aquifolium. Fig. IV. Caulophyllum.

PLATE XVI. Fig. I. Form of *Berberis vulgaris.* Fig. II. *B. amurensis.* Fig, III. Fruit *B. vulgaris*; *III b*, seed; *h*, hilum; *III c*, cross section of seed; *e*, embryo; *en*, endosperm.

NOTES ON COCCIDÆ OCCURRING IN IOWA.

HERBERT OSBORN.

Aside from the interest attaching to this family of the Homoptera as a remarkably specialized group of insects, the fact that it includes some of the most destructive insects affecting woody plants, and that one member of the family, the San Jose scale, is at present spreading rapidly throughout the eastern United States, and a most serious menace to the fruit interests of Iowa, is sufficient reason for giving it a special notice at this time. It seems also unnecessary to apologize for including in this article some matter for the use of teachers, students, and others who may be called upon to examine scale insects in connection with the popular interest that is bound to appear with the further extension of the San Jose scale.

The Coccidæ in general are scale-like insects that with few exceptions become permanently fixed to the bark upon which they occur. The females once fixed never leave the point of attachment unless it be to move from leaf to twig for winter security, but the males undergo a very marked transformation and appear as delicate bodied creatures with one pair of wings.

In a few cases as with the mealy bugs, attachment is not permanent and no scale is formed, while of the scaled forms there are two distinct types, the shield or armored scales (Diaspinæ), having a separated waxy scale, and the unarmored scales (Lecaninæ), having the waxy secretion not separated from the body.

Our state fauna includes representatives of all the subfamilies, and in an enumeration of the species we can point out the characteristics and give such details of generic structure as will be of service to those specially interested.

A number of the records given here are based upon specimens collected by Mr. Wilmon Newell.

COCCINÆ.

In this sub-family the adults are usually active and remain distinctly segmented through life, but in *Kermes* they become fixed. The body terminates in a pair of lobes, bearing bristles, and there are no anal plates.

In *Orthezia* the body is covered with calcareous plates of very regular pattern, while in *Dactylopius* there is a waxy secretion of a mealy appearance, easily detached, but usually forming quite definite marginal appendages on each segment.

Kermes differs from both these in losing the segmentation of the body in the adult females, the body becoming globular, gall like, and attached by a narrow ventral line.

Orthezia americana Walk.

The insect referred to this species has been noted at Ames in considerable numbers on one or two occasions, but it must be generally scarce. The genus to which it belongs is peculiar in that the secretion from the body wall forms long parallel filaments or lobes, completely hiding the insect, and is calcareous in composition.

Dactylopius longispinous Targ.

The common mealy bug of greenhouses, while not indigenous, is so fully established everywhere that it must be recognized as belonging to our fauna. It is about five mm. long, oval in form and covered with a white mealy powder. The long thread-like appendages extending backward separate it from the following species.

Dactylopius citri Rossi.

This species is found occurring in the greenhouse at Ames, on *Dieffenbachia* and foliage plants. It is easily separated from the preceding by the short marginal appendages.

Dactylopius trifolii Forbes.

A species found here on clover some years ago, but of which no perfect specimens for determination were available, may quite certainly be referred to the form described from the same plant by Professor Forbes. It has never been observed in great abundance and probably does not rank as a very destructive species.

The *D. sorghiella* of Forbes in all probability will be found also in Iowa.

Kermes galliformis Riley.

The striking resemblance of these scales to the galls occurring on oak leaves is sufficient to deceive the expert as well as the uninitiated. Taken from oak, on the under surface of the leaves and upon the twigs, at Ames.

LECANINÆ.

The members of this sub-family are with few exceptions permanently attached as adult females; the anal opening is covered with two small lobes, the scale is formed of a waxy secretion and is not separated from the body, and the legs and antennæ are retained in the adults.

Lecanium hesperidum.

This widely distributed and abundant species is familiar to all who keep oleanders, and it occurs also on a long list of other plants, but mostly greenhouse species. Its greasy brown oval scale is very conspicuous and cannot fail to attract attention. It is about three mm long. It is stated that the male has never been found, although the species has been studied from the time of Linnæus down.

Lecanium hemisphaericum Targioni.

Another greenhouse pest occurring on oranges, palms, and various plants. It is much more convex, approaching hemispherical. It is about 3.5 mm. long and three wide.

Lecanium oleæ Bernard.

This species has been taken on *Ficus* and *Naphitum litschii*, in the greenhouse at Ames.

Pulvinaria innumerabilis Rathvon.

This has been definitely recorded for a number of localities in Iowa, and it at times becomes so abundant as to prove a veritable pest. The monograph of the species by J. Duncan Putnam, of Davenport, is a most elaborate and valuable study and the basis of much that is known concerning the habits and life histories of these puzzling insects.

Specimens referred to this species have been taken from basswood the past summer.

DIASPINÆ—THE ARMORED SCALES.

In this group the adult females are permanently fixed and covered by a scale separate from the body and formed by the exuviæ and waxy secretions from the dorsal surface. The legs and antennæ become useless and much aborted, while the anal segment is specialized and furnishes the most important structural characters,—visible only with the compound microscope.

Parlatoria ziziphe Lucas.

I have on one occasion secured specimens of this species from lemon bought in the market at Ames*. It occurs in enormous abundance on the orange in the vicinity of Naples, Italy, and the fruit, branches, and leaves exposed in the Naples markets are often loaded with the scales. Its black color and the quadrangular form of the scale are striking characteristics that enable one to recognize it at a glance.

Mytilaspis pomorum Bouche.

This, the "Oyster Shell Bark Louse," which attracted much attention some twenty to twenty-five years ago, and which for many years caused great havoc in the orchards of the state, is still to be met with in many orchards but in most cases in rather limited numbers. At present it occurs in considerable abundance on certain lilac bushes at Ames.

Various agencies appear to hold it in check during most of the time, and its recognition and subjection present no such serious problem as confronts us in the case of *perniciosus*.

Mytilaspis citricola Pack.

This can scarcely be called a member of our fauna, as its occurence in the state is dependent on its attachment to oranges and lemons that come into our markets Its frequent appearance in this manner is, however, sufficient reason for its mention here, and it may easily occur on trees in greenhouses, as do a number of tropical Coccids that have now a world wide distribution.

Chionaspis salicis Linn.

The white glistening scales of this species, often covering the branches of willows, makes it a very conspicuous species. It is

*This is possibly from imported fruit, as I know of no records of the occurrence of the species on trees in this country.

abundant at Ames and doubtless occurs generally over the state where willows are grown.

Chionaspis ortholobis Comst.

Taken by Mr. Newell on cottonwood at Ames. It resembles the preceding species but is shorter and broader.

Chionaspis pinifoliœ Fitch.

This species, which is common on pine and spruce, and which has been received from Davenport and has been collected at other points along the Mississippi, has never been seen at Ames, a fact which shows very strikingly the limited powers of unaided distribution possessed by these insects and the great importance of preventing the transportation of infested trees. The scale is slender and white, closely fitting the narrow leaves on which it occurs.

Chionaspis furfurus Fitch.

This is probably the most generally distributed and injurious scale insect infesting orchards in Iowa at the present time. The female scale is flattened, broadly oval or rounded, and the exuviæ at one end, and the male scale is narrow, white, with three carinæ, one central and one at each side. The eggs remain under the scale during the winter and hatch about the first of June.

Diaspis rosœ.

Specimens of this species were recieved from Muscatine in 1896, and a record made in the last volume of the Academy. It has been received from Davenport also. It is not apparently distributed over the state, but it thrives on a variety of plants as well as the roses, and its dispersal should be prevented as far as practicable. Like many other species it is often mistaken for *perniciosus*, but its white color, larger scale, and position of the exuviæ will enable a careful observer to distinguish it by means of the scales alone.

Diaspis cacti Comst.

The various members of the cactus family are infested with this species, and greenhouses may usually be depended upon to furnish a supply. Mention of this species was made in 1882, since which Professor Comstock has given it a technical description.

Aspidiotus ancylus.

Originally described from specimens taken at Davenport, this species has attracted little attention until within a few years, when the close resemblance of its scale to that of the San Jose has made it well known. It is very small and usually too few in numbers and scattered to attract attention. Mr. Newell has recently collected it at Ames from maple, cherry, plum, and birch, and it evidently has a general distribution in the state.

Aspidiotus ancylus var *serratus* Newell and Cockerell n var.

This occurs very sparsely on native willows. The scale of the female is small, less than one mm in diameter, and dark grayish, the same color as the bark of the host.

This form differs materially from *ancylus* proper in the following characters: Median lobes more truncate and minutely serrate at end. The glandular thickenings of the first interlobular interval are about equal.

A very small and obscure variety that is difficult to detect, but which is of little economic importance.

Aspidiotus forbesi Johns

This species has been collected at Des Moines and at Ames and doubtless has a general distribution through the state, although its minute size and usually scant numbers seldom bring it to notice. It is one of the most closely related to the San Jose scale, and without close microscopic study is separated only with great difficulty. It occurs on cherry, apple, crab, ash, and a number of other plants.

Aspidiotus osborni Newell and Cockerell n sp.

Scale of female small, oval, 1 to 1.25 mm. in length by $\frac{1}{2}$ to $\frac{3}{4}$ mm. in breadth, irregularly margined, dark, spotted minutely, and of a general scurfy appearance; exuvia dark brown, submarginal, small; scale of immature female more elongate and frequently curved to one side; ventral scale a mere white film.

Body of female circular, last segment yellow. Ultimate ventral segment: median lobes well developed, close together, produced, comparatively long and narrow, erect, scarcely or not at all notched on the inner side near end, but well notched about half way down on the outer side, ends sometimes minutely serrate; second and third lobes wanting; two incisions present, the glandular thickenings of the first incision long, about equal, well apart, outer straight, the inner nearly so, glandular thickenings of the outer incision like those of the first, a small thickened process just laterad of apex of first incision; plates spine-like, about equal in length to median lobe, often angularly curved near apex, situated, one

laterad mesal lobe, two laterad first incision, two just laterad of second incision, and one about one-third the distance from the second incision to penultimate segment, and several smaller plates irregularly placed on anal margin; edges of penultimate and antepenultimate segments usually provided each with a spine-like plate; ventral-grouped glands, cephalolateral about seven, caudolaterals three or four, median none.

This species is closely allied to *A. ancylus* Putn., but differs in the character of the scale, the median lobes are narrower and more produced and lack the well defined inner notch, and the number of the ventral glands is different. In *ancylus* the inner thickening of the first incision is decidedly larger than the outer, in marked contrast to the nearly equal thickenings of *osborni*. Described from sixteen females and numerous scales collected from white oak at Ames, Iowa.

Aspidiotus juglans-regiæ Comst.

This species is common in more southern localities and has been observed in Iowa for the first time during the present season. It was received from Alton, Sioux county, where it occurred in great abundance on currant bushes and was thought possibly to be the San Jose. It was introduced from Texas, but evidently thrives in its present habitat. It may easily prove a serious pest, but has never been considered as approaching *perniciosus* in destructiveness. It is a much larger species than *perniciosus*, the scale being about three mm. in diameter, so that it may be easily recognized without microscopical examination even.

Aspidiotus nerii Bouche.

A very common and at times a very destructive species, but fortunately not spreading to any extent upon native plants. It is particularly inimical to the Oleander and it is not uncommon to see these plants completely encrusted with the white circular scales. I have received specimens from Des Moines and it has been taken on *Cycas revoluta* in the greenhouse at Ames.

Aspidiotus ficus Riley Mss.

On *Ficus unica*, and *Ficus* sp in the greenhouse at Ames. A very similar species, if not identical with this, also occurs on *Daphne odorata*, but on account of their being parasitized, good specimens for determination were not available.

Aspidiotus rapax Comst.

This species occurs on *Osmanthus* and other plants in the greenhouse at Ames. This species is abundant and destructive

on a great variety of plants, but has never proved troublesome to native plants outside the lower austral zone.

While the San Jose scale has not as yet been received from any point in Iowa we can hardly hope to remain exempt from its attacks. It is of the utmost importance to recognize it at once in case it appears in any locality. The scale is circular and the exuviæ form a nipple-like elevation at or very near the center. No eggs will be found under the scales, as the females produce living young, and a microscopic examination of the last segment of the female shows an absence of the grouped ventral glands common to related species. All scales, however, that can not be referred certainly to some of the above named species had best be sent at once to the experiment station or referred to some one thoroughly acquainted with the characters by which it is recognized.

ON THE OCCURRENCE OF THE WHITE ANT (TERMES FLAVIPES) IN IOWA.

BY HERBERT OSBORN.

I am not aware of any published record of the occurrence of *Termes flavipes* in Iowa and aside from a note book record by J. Duncan Putnam I have not until the present year been able to secure any definite facts that would warrant listing it as belonging to our fauna.

Last year Mr. F. M. Rolfs stated in one of my classes that he had seen this species at his home in Le Claire in Scott county, and when he returned to the college from his summer vacation this year he brought with him a number of examples of the workers and soldiers collected at that place.

The well known habits of this insect and the great economic importance it sometimes assumes where it gets access to stored books or documents, or to the timbers of bridges and buildings, render this definite occurrence of sufficient interest to record.

In all probability the species occurs throughout the timbered portions of the state, adjacent to the Mississippi at least. I think it hardly possible that it can occur at Ames, as I have examined thousands of old stumps and logs in quest of insects and have never yet met with it there.

ADDITIONS TO THE LIST OF HEMIPTERA OF IOWA, WITH DESCRIPTIONS OF NEW SPECIES.

BY HERBERT OSBORN.

A number of additions to the Hemipterous fauna of the state have been made during the last year, either by collection or by the determination or description of specimens previously in hand, and although there are certainly many others to add it seems desirable to record such as have come to notice. In many cases the record greatly extends the range of the species as heretofore known.

HETEROPTERA.

FAMILY SCUTELLERIDÆ.

Homœmus æneifrons Say. Rare, three specimens, Ames.
Homœmus bijugis Uhler. Ames, Little Rock.

FAMILY CYDNIDÆ.

Geotomus sp.

FAMILY PENTATOMIDÆ.

Perillus circumcinctus Stal. One specimen, Sioux City, July 7, 1897.

Mecidea longula Stal. One specimen, Sioux City, July 5, 1897.

Trichopepla atricornis Stal. Little Rock and Ames.

Peribalus piceus Dallas. Two specimens, Little Rock. Collected by E. D. Ball.

Holocostethus abbreviatus Uhl. One specimen, Ames. Easily confused with *Peribalus limbolarius*.

Banasa dimidiata Say. Ames, not common.

FAMILY COREIDÆ.

Chariesterus antennator Fab. One specimen, Sioux City, July 5, 1897.

Catorhintha mendica Stal. Ames.

Harmostes reflexulus Say. Ames and Sioux City.

Aufeius impressicollis Stal. Ames.

Corizus lateralis Say. Ames.

Daycoris humilis Uhl. Little Rock. Collected by Mr. Ball.

FAMILY LYGÆIDÆ.

Pamera vicina Dallas. Ames, Little Rock.

Rhyparochromus floralis Uhl. Ames.

Scolopostethus affinis Uhl.

FAMILY CAPSIDÆ.

Teratocoris discolor Uhl. Ames and Little Rock. Rare.

Pallacocoris suavis Reut. Sioux City.

Lopidea strigta Uhl. Ames.

Lopidea fuscicornis Uhl. Little Rock.

Lopidea nigrida Uhl. Ames.

Lomatopleura cæsar Reut. Ames, Little Rock, Sioux City, Cherokee.

Hadronema pulverulenta Uhl. Ames.

Phytocoris eximius Reut.

Phytocoris puella Reut.

Phytocoris puella var.

Phytocoris sp.

Melinna fasciata Uhl. Ames. Common in 1897.

Melinna modesta Uhl. Common at Ames, 1896 and 1897.

Largidea opaca Uhl. var.

Fulvius anthocoroides Stal. One specimen, Ames, August 6, 1897.

Mimoceps gracilis Uhl. Ames and Little Rock.

Sthenarops malinus Uhl. Ames. Common.

Macrolophus separatus Uhl. Ames.

Episcopus ornatus Reut. Ames and Des Moines.

Plagiognathus obscurus Uhl. Ames.

Coquillettia mimetica n sp. Ames.

Sericophanes ocellatus Reut. Dimorphic female, ant like.

FAMILY TINGITIDÆ.

Leptostyla oblonga Say. Ames. Common,

FAMILY ARADIDÆ.

Neuroctenus simplex Uhl. Ames. October 11, 1897. On grass far from timber.

FAMILY NABIDÆ.

Coriscus annulatus Reut. Ames.

SALDIDÆ.

Salda deplanta Uhl. Ames. Plentiful during 1897.
Salda ligata Say. Le Claire. (J. A. Rolfs.)

HOMOPTERA.

FAMILY BYTHOSCOPIDÆ.

Macropsis apicalis O. & B. Ames.
Pediopsis trimaculata Fh. Ames.
Pediopsis basalis V. D. Ames.
Pediopsis bifasciata V. D. Ames.
Pediopsis ferruginoides V. D. Ames
Pediopsis suturalis O. & B. Ames.
Pediopsis erythrocephalus G. & B Ames.
Pediopsis gleditschiæ O. & B. Ames. Very common on honey locust.
Pediopsis reversalis O. & B. Ames. Very common on willow
Agallia uhleri V. D. Sioux City, July 7, 1897.
Agallia cinerea O. & B. Sioux City and Little Rock in July.
Idiocerus pallidus Fh. Ames.
Idiocerus duzeii Prov. Ames.
Idiocerus brunneus O. & B. Ames.
Idiocerus snowi G. & B. Ames.
Idiocerus moniliferæ O. & B. Ames.

FAMILY TETTIGONIDÆ.

Gypona pectoralis Spang. Ames. Rather common.
Gypona cinerea Uhl. One specimen collected at Little Rock,

FAMILY JASSIDÆ.

Dorycephalus vanduzei O. & B. At Little Rock. Collected by E. D. Ball.
Parabolacratis flavidus Sign. (?). One specimen, Audubon (Ball).
Paramesus stramineus n. sp. Ames, Sioux City, and Little Rock.
Deltocephalus imputans O. & B. Ames.
Deltocephalus obtectus O. & B. Ames.
Deltocephalus cruciatus O. & B. Ames.
Deltocephalus collinus Dahlb. Little Rock and Sioux City. July.

Scaphoideus ochraceus n. sp.* Ames.

Scaphoideus picturatus n. sp. Burlington.

Lonatura catalina O. & B.† Ames, Sioux City, Burlington.

Lonatura megalopa O. & B. Little Rock.

Driotura robusta O. & B. Sioux City, July 7, and Little Rock.

Athysanus anthracinus V. D. Ames.

Athysanus parallelus V. D. Ames.

Athysanus osborni V. D. Ames.

Athysanus punctatus O. & B. Ames and Little Rock.

Eutettix scaber O. & B. Ames.

Eutettix cincta‡ O. & B. Ames.

Eutettix modesta O. & B. Ames.

Phlepsius lobatus n. sp. Ames and Little Rock.

Thamnotettix cyperaceus n. sp. Ames.

Thamnotettix ciliata n. sp. Ames.

Thamnotettix pallidula n. sp. Ames.

Chlorotettix balli n. sp. Ames.

Alebra albostriella Fall. Ames.

Typhlocyba comes var. *ziczac* Walsh. Ames.

Typhlocyba querci Fh. Ames.

Typhlocyba rubrasvula var *bifasciata* O. & B. Ames. Berwick (Mally).

Typhlocyba lethierry Edw.

Typhlocyba rosæ var. *commisuralis* Stal. Ames.

FAMILY CERCOPIDÆ.

Philænus bilineatus Say. Little Rock (Ball).

FAMILY FULGORIDÆ.

Kelisia axialis V. D. Ames.

Kelisia crocea V. D. Ames.

Liburnia osborni V. D. Ames and Fairfax.

Liburnia puella Van D. Ames.

Pentagramma vittatifrons. Uhl. Ames. Rare.

Laccocera vittatipennis Van D. Little Rock.

Pissonotus aphidioides Van D. Ames.

Pissonotus brunneus Van D. Ames.

Pissonotus marginatus Van D. Ames.

Pissonotus ater Van D. Ames.

Myndus impunctatus Fitch. Ames

Peltonotus histrionicus Uhl. Little Rock.

*Description of new species included in the list are appended at end of list.

†Listed in the additions of previous papers as *Doratura minuta* on mistaken identification.

‡Heretofore listed as *Eutettix jucundus* Uhl.

FAMILY MEMBRACIDÆ.

Vanduzea vestita Godg Ames, Little Rock, Sioux City, on *Petalostemon*.

Ophiderma flaviguttata Godg. Ames.

Heliria strombergi Godg. Ames.

Telamona pyramidata Uhl.

COQUILLETIA MIMETICA N. SP.

Ferruginous or ferruginous brown to fuscous. Females apterous, and simulating an ant Male with very long wings and slender abdomen, ostea

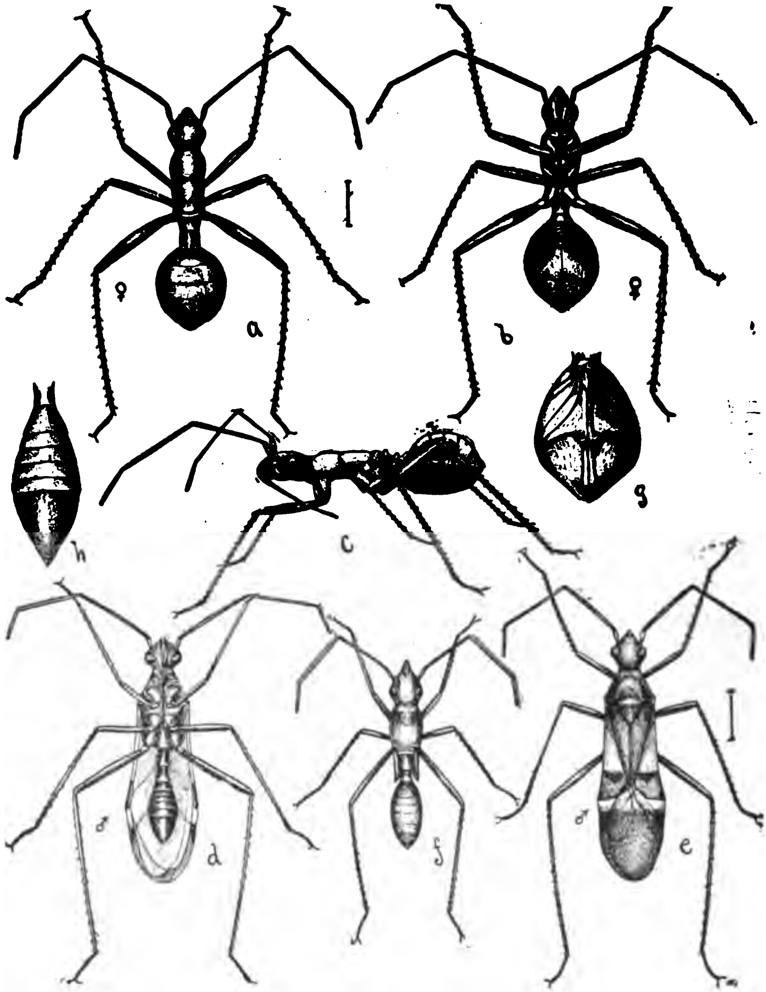

Fig. 15.

Coquilletia mimetica. *a*, female dorsal view. *b*, female ventral view. *c*, female lateral view. *d*, male ventral view. *e*, male dorsal view. *f*, larva. *g*. female abdomen enlarged *h*, male abdomen enlarged. (From drawings by Miss King.)

curved, inflated, extended posteriorly, margin second abdominal segment white.

Length: female, 5.5 mm., male, 4.5 mm.; to tip of elytra, 6.5.

Apterous female. Head wider than pronotum, convexly narrowing to the pointed tylus, eyes moderately prominent, their outline conforming to the margins of the head; antennæ long, nearly equaling the length of body, first joint short, not passing the tylus; second joint longer than third and slightly thicker; fourth joint half as long as second, more slender than third, slightly curved; rostrum exceeding middle coxæ, first joint extending to border of buccula—remaining joints subequal, pronotum somewhat tumid, narrowed to form a collar in front, mesosternum slightly convex with marginal carinæ and slightly produced on metanotum; metanotum short, elevated laterally, carinate. Legs long, slender, coxæ strong. Abdomen with first two segments constricted to form a pedicel, the first one strongly elevated in a broad process in front and with an elevated posterior margin and the pleura forming a sharp lateral elevated carina or lamina, the second slightly wider behind, the lateral carinæ less prominent, remaining segments forming a globose, polished, minutely, sparsely haired body with conspicuous pleural fold, and elongate carinate sheath for the ovipositor. The ovipositor originates close to base of the globular portion of abdomen, the sternal parts of segments being extremely narrow and the sheath formed from the sixth, seventh, and eighth sternites.

Color brown, with the eyes, rostrum, apex of second joint and all of joints three and four of the antennæ, apex of tibiæ and the tarsi, fuscous or blackish. The globose portion of abdomen and dorsum of second segment are dark chestnut or piceous. The border of the ostea, a narrow posterior margin on first abdominal segment, the posterior border of second abdominal segment except the dorsum, light yellow or white.

Male. Head smaller, slightly more globose and eyes more prominent than in female. Pronotum widened at base, the sides nearly straight, the basal portion elevated and the posterior margin slightly concave. Scutellum large, swollen in front with a transverse area and an impressed line on the disc, the posterior portion carinate. Elytra broad, long, with a semi-transparent area at the basal half of the corium and another occupying basal part of cuneus; mesoternum large, polished, ostea large and curved internally, enlarged laterally and prominent. Legs slender. Abdomen very slender, pedicelate, polished, minutely pubescent, scarcely one-third width of elytra and extending about two thirds their length, the terminal ventral segment narrowing posteriorly, strongly curved upward, dorsally tubular, the claspers simple.

Color: Head, basal part of antennæ, anterior lobe of pronotum, scutellum, clavus, posterior half of corium, pectus, femora and part of tibia, and basal portion of abdomen testaceous or testaceo-ferruginous and polished except the rather ferruginous parts of elytra. Joints 2, 3, 4 of antennæ, apical portion of tibia, tarsi, cuneus except the base, and membrane of elytra blackish, apical portion of venter piceous. The basal transparant portion of elytra and a broad oblique band forming base of cuneus, the border and inflated exterior portion of ostea and posterior margin of second abdominal segment, white.

The larvæ are similar to the adults in color and form, but have the peculiar structure of the abdomen less marked.

This insect is of special interest inasmuch as we have as yet no winged form of female and only the winged form of the adult male. The apterous female form is remarkably ant-like in shape and appearance, as are in less degree the larvæ. They were at first supposed to be larvæ, but it was noticed that all the winged forms were adult males and an examination of all the wingless forms with the globose abdomen proved them to be mature females.

They have been found only on elevated grassy ridges and probably feed on some of the grasses, such as *Bouteloa*, which are common to prairie and plain.

An ant of an undetermined species and extremely like the female in appearance has been taken from the same locality.

In the figures the head is represented as raised on a level with the prothorax, but in pinned specimens and probably in the living individuals when not moving the head is bent downward and the prothorax curved on mesothorax, giving still more of an ant-like appearance.

Professor Uhler established the genus *Coquilletia* to include *insignis*, of which he remarks that only males have been seen. There can be little doubt that its female is also apterous, and on this account has escaped collection.

While possible that winged females may occur, it is evident that the apterous condition is the usual one.

SERICOPHANES OCELLATUS REUT.

This handsome little Capsid presents an interesting case of dimorphism and also of mimicry, the brachypterous female closely resembling an ant in the large pedicellate globular abdomen.

Only the winged form, and presumably only the male, has hitherto been described, and that very briefly.

Brachypterous form.—Female: Ant-like the elytra reduced to rudiments reaching only to end of second abdominal segment. Abdomen from third segment globular. Head, thorax and abdomen polished. Length, 2.50 mm.

Head large, the space between the eyes equaling the pronotum in width; eyes large; antennæ moderately long, not longer than length of body; first joint thick, not reaching the end of tylus; second joint larger than third; fourth rather shorter than third; prothorax sub-globular, highly polished; scutellum broad, triangular; elytra reaching to or slightly upon the

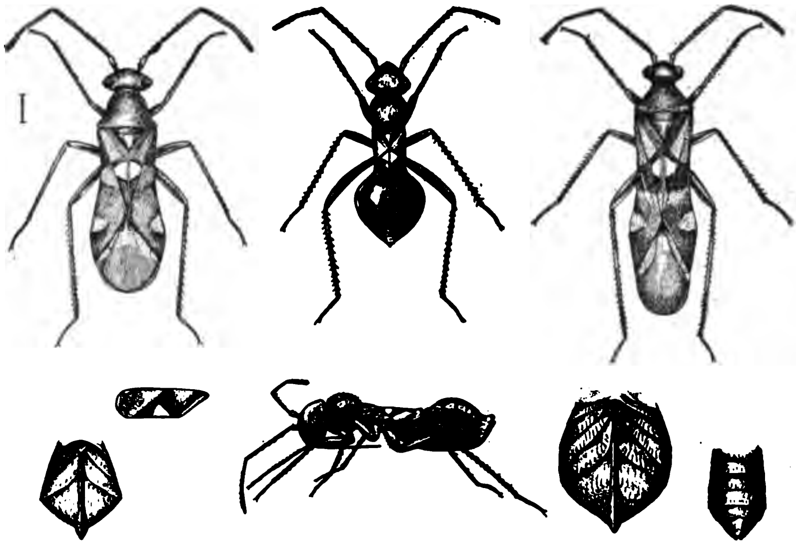

Fig. 16.

Sericophanes ocellatus. Dorsal views macropterous female at left, micropterous female in middle. Male at right. Below, ventral views of female abdomen macropterous at left, micropterous at right. Male extreme right.

globular portion of abdomen; wings wanting or very rudimentary; abdomen at base slender; joints three to eight forming a sub-globular, slightly flattened broad portion; a prominent pleural fold extending from the base to end of seventh segment.

Color: Head, thorax, elytra, base of abdomen, the second joint of antennæ, femora, tibiæ and base of tarsi reddish brown; first joint of antennæ yellow; a bright yellow spot on elytra as in macropterous forms, apex of second joint and all of third and fourth, and tips of tarsi fuscous. Abdominal 4-7 segments black or pitchy brown entirely, beneath in two triangles, the apices of which nearly meet in the median line.

No brachypterous male has been observed.

Macropterous form.—Female: Similar to brachypterous form but with fully developed elytra and wings, a much less extended abdomen, and the pronotum widened at base with prominent angles. Length, 2.50, to tip of elytra, 3 mm.

Head smaller and with front less convex than in brachypterous form; antennæ similar; prothorax much less tumid, narrower in front and widening posteriorly to form prominent humeral angles, and with the posterior margin overlapping scutellum and base of elytra; scutellum similar or a trifle larger; elytra broader and shorter than in males; the tip of corium not projecting as an obtuse angle; wings reaching to tip of elytra; abdomen slender at base, expanding to end of seventh segment, where they are almost as wide as the folded elytra, then contracting sharply to tip, flattened, the tip of ovipositor projecting.

Color the same as in the other forms, but in the specimens in hand the lower part of head and under surface of abdomen is somewhat suffused with rufous. The three powdery white bands on the elytra and the bright yellow across the clavus just back of the scutellum are very distinct. A spot each side of the central yellow ocellus and the cuneus are more golden brown than the rest of the elytra. The membrane is fuliginous except a transverse band at base and a narrow margin to the cuneus which are whitish transparent.

Male: More slender, darker, head smaller and eyes more prominent. Length 2 mm.; to tip of elytra 3.10 mm.

Head nearly vertical, eyes prominent, prothorax strongly declivous, widening to humeral angle; scutellum triangular, similar to female. Elytra long, narrower than in female and with the end of corium and base of cuneus forming an obtuse angle. Abdomen slender, flattened, the sides nearly parallel.

Color, dark brown or chestnut, the lower part of head a little lighter or tinged with rufous; the first and second joint of antennæ are yellowish and the spot on dorsum back of scutellum is light yellow; the elytra are chocolate brown with band inclosing the ocellate spot and the cuneus golden brown; three broken whitish or pruinose bands across the elytra, the point of scutellum and ocellate spot not quite reaching costal margin and the third at base of cuneus represented by a triangular patch next the costa; membrane as in the female; mesosternum piceous, polished, abdomen fuscous or blackish, yellowish-brown at base, polished.

Larvæ taken with adults present similar characters, but are quite remarkable in the greatly inflated terminal joint of the antennæ. The bodies are too much shriveled to permit of description.

The macropterous females were collected May 28th and June 7th, the brachypterous females May 22d, June 3d–7th and 12th, and July 31st, the males June 2d–7th and July 28–29th. Larvæ July 28th. This indicates a rapid development of the larvæ between the 1st of June and the latter part of July and probably two broods for the year, but no rearing of the larvæ or exact limitation of the broods has been attempted. They occur on grassy ridges in same location as preceding species.

The significance to be attached to the peculiar dimorphism and mimicry presented in this and the preceding species opens a question of too far reaching importance to be discussed here. That they resemble ants is certain, that they may by this resemblance gain some advantage is possible, but whether the abortion of the wings and elytra is merely the result of such mimicry or connected with advantages of an entirely different nature we are not prepared to guess. I have used the term mimicry in a general way to cover this feature of resemblance but I would dissent from the use of this term in such a loose manner if a better one were available. Such resemblances

seem to me not of necessity mimicry in its proper sense, or protective resemblance but merely the assumption of a similar form by different animals when adapting themselves to similar environments. The question readily broadens into a discussion of all the factors of adaptive evolution and while attractive is too large to attack in such a paper as this:

PARAMESUS STRAMINEUS N. SP.

Very similar to *P. twiningi* but of a light greenish-yellow color, the dark band of elytra absent and the lower half of face light yellow. Length to tip of elytra, female 5.50 mm., male 4.50 mm.

Vertex rounded at apex, one-half longer at middle than next eye, anterior two-fifths rising to form a distinct, elevated, angular margin Front sinuate next antennæ then narrowing uniformly to base of clypeus; clypeus twice as long as wide, widening to apex; genæ sinuated below eye, scarcely angular laterally, reaching clypeus by a narrow line; loræ elongate, angular at ends, twice as long as wide, their lower ends not reaching clypeus by a considerable space. Pronotum minutely transversely rugulose on posterior two-thirds, evenly arcuate in front, scarcely concave behind and with a very shallow emargination near the middle, lateral margin short, with a distinct carina, humeral margin distinct, rather short, angles subprominent. Elytra with a few ramose nervures in clavus and between second sector and claval suture.

Color: Vertex, anterior two-fifths ivory white with two large, black, angular transverse spots near middle and a smaller, irregular, lineate fuscous one each side near eyes; the posterior two thirds uniformly greenish-yellow or pallid with a longitudinal black impressed line at center. Face dark in upper half and light in lower; a conspicuous black line from eye to eye just below margin of vertex; front fuscous with light lines; clypeus light fuscous; genæ and loræ yellow, sutures black; pronotum greenish on disk and posteriorly with bluish tint; front, margin, and sides more yellowish, faintly mottled with irregular whitish maculations; scutellum ochre yellow with whitish triangle on lateral margins and at tip, and a faint fuscous line separating the usual areas; elytra hyaline or pellucid with the few ramose lines, a spot in the second, third and fourth apical, the middle and inner anteapical cells, and an apical submargin, fuscous; apex of clavus and costal transverse nervures dark fuscous or black; beneath light yellow spotted and lined with black; tergum black with yellow maculate margin.

Genitalia: Female, ultimate ventral segment long, posterior margin broadly, shallowly excavated and bearing at center a ligulate process about as long as wide and minutely notched at tip, pygofers posteriorly set with minute remote short gray hairs arising from black points; male, valve very short, scarcely visible; plates elongate triangular, reaching to tips of pygofers, margins with a few hairs.

Described from five females and one male. Of the females two were collected at Sioux City, July 7th, one at Sioux Falls, S. D., July 4th, and one at Ames, June 15th; and one collected

at West Point, Neb. in June has been sent to me by Professor Bruner. The male was collected by Mr. Ball at Little Rock, Iowa, July 2d.

While this form is strikingly like *twiningi* in general characters the very marked difference in color, the absence of black bands on the elytra, and the differently colored face cannot fail to distinguish it, and until intermediate forms are found or it can be proven by life-history details that they intermingle it must stand as distinct. It evidently belongs to the plains fauna and probably feeds upon some of the Compositæ.

SCAPHOIDEUS OCHRACEUS N SP.

In size and color resembling *jucundus* but in venation like *intricatus* or *luteolus*. Tawny ochraceous and pallid with most of the elytral nervures fuscous. Length to tip of elytra, female 6 mm., male 5 mm

Vertex as long as width between the eyes, nearly as long as pronotum, the margin angularly rounded; front, narrow; margins slightly concave next the antennæ, tapering uniformly to base of clypeus, which it equals in width. Clypeus twice as long as width at base, broadening to the apex, which is distinctly truncate; loræ oval, sub-angulate at tips, twice as long as wide; genæ broad, slightly concave below eyes and sub-angulate on margin forming a narrow margin below loræ.

Elytra with the first two reflexed costal veinlets very oblique, as in *immistus*, the first originating at or just in front of the transverse veinlet; the second near the middle of the outer anteapical cell; the third at the end of the anteapical cell but not touching the apical veinlet. In one specimen an extra oblique vein occurs between first and second.

Color: Vertex yellow with a broad ochraceous or ochraceous-rufus band across the disk, the median portion forming a short curve and reaching the width of the band toward the apex, sometimes almost interrupted; the anterior border with a fuscous line broader, fainter, and broken at the apex; front yellow with two black or fuscous lines running nearly from eye to eye, and three or four short broken arcs becoming obsolete toward the middle; a small fuscous spot on genæ below the insertion of the antennæ; pronotum with two large spots on the anterior margin near the middle; the posterior half, except narrow median line, two large lateral spots and a slightly fainter median stripe, a wide border to nearly all the nervures and the apex of elytra, ochraceous; a spot at end of inner claval nerve a short line at end of outer claval nerve, an elongate sp t at end of clavus, a spot in inner discal area, interrupted lines on the nervures most conspicuous on the reflexed veinlets and next the costa and a sub-apical border, fuscous; the elytral cells whitish hyaline; below light yellow and pallid; the posterior border ultimate ventral segment female, terminal bristles on pygofers; a series of points and terminal annulus on tibia, tip of first joint and all of second joint of tarsus, deep fuscous or black.

Genitalia: Female, ultimate ventral segment long, the posterior border straight or very slightly produced at the middle. Pygofers full, polished,

with marginal and terminal bristles, the latter strong; male, valve very short, transverse; plates broad, roundingly narrowing to obtuse tip with weak marginal bristles; pygofers rather broad, extending half their length beyond the plates and set with long, stiff bristles.

Described from twelve females and seven males collected at Ames from July 29th to August 13th.

While this species has the general color of *jucundus* it differs from that species very distinctly in the oblique reflexed veinlets and in having the transverse band on the vertex instead of the two parallel spots. From *immistus*, *intricatus* and *luteolus*, which it resembles in venation, it differs in color and size.

SCAPHOIDEUS PICTURATUS N. SP.

Color pattern very similar to *sanctus*. Head more sharply angular, reflexed veins less oblique or indistinct. Length to tips of elytra, female 5 mm., male 4 mm.

Vertex sharply angulate at the tip, as long as width between eyes, and nearly twice as long at middle as next eye. Front very slightly widening next antennæ, tapering uniformly to base of clypeus; clypeus with sides parallel, base and apex convex; loræ small, suboval; genæ roundingly angulate below the eyes. Pronotum sharply arcuate in front, truncate behind, lateral margin extremely short; scutellum small, the elytra with the post-nodal veinlets irregular, the first either absent or not reflexed, the second strongly reflexed, the middle and inner anteapical cells with distinct or obsolete cross nervures.

Color: Vertex, anterior part of pronotum, scutellum, face, pectus, venter and margin of abdomen above, yellow or greenish-yellow; two minute points next each eye, two short oblique lines near tip, and a very slender median line on vertex, three or four strongly curved arcs on the front, the margins of the olivaceous areas, an oblique band near the tip, and a submarginal border on the elytra, fuscous. The elytra are fusco-olivaceous, interrupted with ivory white as follows; a broad oblique band on the base of corium and clavus paralleling the sides of the scutellum, a discal spot at forking of the first sector, a commisural spot and a broad band across the base of the anteapical cells. The nervures are white on the white portions and also in the fuscous part at apex.

Genitalia: Female, ultimate ventral segment short, slightly notched on the median line; pygofers thickly set towards tip with rather fine bristles; male, valve small, plates long, tapering gradually to the obtuse tip, exceeding the short pygofers. Both plates and pygofers are finely ciliate with pale hairs.

Described from one female received from Prof. H. Garman, Lexington, Ky., and one male which I collected at Burlington, September 5, 1897.

While this appears superficially to resemble *sanctus*, the different venation and the different markings on the vertex as

well as the very different genitalia renders it easily separated from that species. In venation it approaches *Deltocephalus* and adds another link to the chain connecting the two genera.

THAMNOTETTIX CILIATA N. SP.

Green or yellowish-green, the under part of thorax and nearly all of abdomen black. Head with four quadrate black spots on margin between eyes and two on the vertex behind the outer ones. Length to tip of elytra, female 5.50 mm., male 5 mm.

Vertex subangulate in front, about one-half longer in middle than next eye. Front tapering evenly to the broad apex, apical angles rounded; clypeus widening but slightly to the truncate tip, nearly twice as long as wide; loræ large, nearly reaching tip of clypeus, genæ broad, sides rounding reaching the clypeus by a narrow line. Pronotum one-third longer than vertex, slightly emarginate posteriorly, humeral margins long, lateral margins short, rounded; elytra long, narrowed, the nervures distinct, becoming fainter near costa towards apex.

Color: Head yellow with a conspicuous transverse row of four quadrate black spots on margin of vertex extending down on to the front, two small approximate spots or lines on the disk about half way from occiput to tip, variable in size and a spot on each side near the eye parallel to the outer marginal spot, in some cases reduced to a round dot. A spot at base of antennæ, four or five interrupted arcs on front, and frontal sutures, black; sometimes spots of black on genæ and loræ and an annulus on second joint of antennæ, in female, black Pronotum, greenish transparent, with anterior border more yellow; scutellum yellow; elytra greenish hyaline or flavescent, the nervures yellowish or whitish and in the females usually bordered with fuscous. Tergum black except margin and part of terminal segment y-llow; pectus and venter black, lateral margins, posterior margins of b se and side margins of ultimate ventral segment, a narrow posterior border to the segments and the pygofers of female, and usually plates and pygofers of male, yellow or whitish.

Genitalia: Female, ultimate ventral segment slightly longer than penultimate, minutely rugulose; posterior margin scarcely concave; pygofers large, slightly exceeded by the ovipositor and set with stiff grayish bristles, those at apex stronger and darker; male, valve long, nearly as long as wide, posterior border convex; plates short, divaricate, obtuse or truncate, and bearing a few stiff hairs on disk and a dense brush of long white ciliate hairs from the margin; pygofers long, exceeding plates, obliquely truncate obtuse at tip, their margins set with a series of stiff hairs.

Described from numerous examples of both sexes collected in Iowa and one female from Colorado (Gillette). Adults at Ames from June 2d to July 2d, and from August 27th to October 9th. Three specimens from Little Rock July 2d (Ball), and two from Algona, Iowa, May 9th (Mally).

This species presents many striking resemblances to *smithi;* in fact, specimens of *smithi* having the frontal black band inter-

rupted are scarcely distinguishable except by form of clypeus. Usually, however, *smithi* has a broad, unbroken band, without any traces of spots on the vertex, but with the border of loræ next clypeus with a broad black line, exaggerating the width of clypeus, while *ciliata* seldom or never has the quadrate spots of the frontal band coalesced, and the loræ, while sometimes slightly spotted with black, lack the line next the clypeus.

The greater length and narrower tip of the clypeus, and the broader, more truncate, male plates are the decisive structural characters.

THAMNOTETTIX CYPERACEUS N. SP.

Resembles *melanogaster* but larger and usually more deeply colored, and with three parallel croceus stripes on head and pronotum. Length to tip of elytra, female, 6 mm.; male, 5.25 mm.

Vertex nearly twice as wide on the middle as next the eye, angulate at tip, the margin sharply angular, front narrowing evenly to clypeus, scarcely emarginate next antennæ; clypeus slightly widened and more nearly truncate at the apex; genæ evenly rounded. Pronotum long, about one-half longer than vertex, slightly concave behind, lateral and humeral angles rounded. Elytra long, the nervures distinct, claval nervures parallel.

Color: A broad stripe and a narrower median one on the head; pronotum and scutellum tawny, alternating with yellow. Ocelli red. Four transversely linear spots just below the margin of the vertex (not, or scarcely visible, from above) the insertion of antennæ and the lateral margins of front, dorsum of abdomen except margin and terminal segment, disk of venter and ovipositor black. Elytra tawny hyaline with whitish nervures. Margin of abdominal segments yellow or tinged with rufous posteriorly.

Genitalia: Female, ultimate ventral segment scarcely longer than penultimate, very slightly emarginate on either side of the middle of posterior border. Male, valve produced, large, and rounded posteriorly, with a median impressed line at the tip; plates short, obtuse, and thick at the apex, with dense tufts of hairs and a conspicuous bristle arising from extreme tip; pygofers short, hairy.

Described from four males and four females collected from *Carex* at Ames, Iowa, October 6, 1897. In the disposition of black markings this species almost duplicates *melanogaster*, but it is much larger, the male genitalia are quite different, and other characters will easily separate them.

THAMNOTETTIX PALLIDULA N. SP.

Smaller and lighter colored than *melanogaster* and with the under surface pallid. Approaches *fitchi* but markings are less distinct. Six points in a line across the front part of vertex, either all black or part or all of them faint or obsolete. Length to tip of elytra, 4 mm.

Vertex one-third longer on middle than next eye, very obtusely and roundingly angulate, the margin rounded; front narrowing rapidly from antennæ to clypeus; clypeus nearly twice as long as broad, scarcely widening at apex; loræ small, oval; genæ broad, distinctly angular. Pronotum strongly curved anteriorly, posterior border straight, lateral margins very short. Elytra long and narrow, nervures distinct.

Color: Vertex, pronotum and scutellum light yellow with faint ochraceous stripes, the two median ones extending to margin of vertex and diverging posteriorly to cover the lateral angles of the scutellum, the outer ones on pronotum only. Across the front of the vertex a row of six dots, the inner ones behind the margin the outer ones directly on the margin in front of the eyes, all black or the inner ones faint or obsolete, but those next the eyes are black in all but one of the specimens in hand. The elytra are flavescent or faintly cupreescent with the nervures conspicuously whitish. Beneath, entirely pallid, except the median posterior part of the ultimate ventral segment in female, bordering the notch laterally, and exposed edges of ovipositor, light fuscous. Venter and margins of dorsum in male sometimes more decidedly yellow.

Genitalia: Female, ultimate ventral segment short, the posterior margin produced each side of a median broad and deep notch, the median portion of which is straight or scarcely produced into a very obtuse tooth pygofers set with stiff hairs on the posterior portion; male, valve, anterior margin convex, posterior margin straight; plates triangular, outer margin slightly convex and sparsely ciliated; points acute; pygofers exceeding the plates, obliquely sinuate, acute at tip and bearing rather strong hairs.

Described from eight females and four males collected at Ames, Iowa, by Mr. E. D. Ball.

This species is quite similar to *fitchi* in size but is more yellow in color and the genitalia are quite distinct.

CHLOROTETTIX BALLI N. SP.

Resembling *unicolor* and *spatulatus* but more yellowish-green and with the vertex subangulate. Ultimate ventral segment female with a spatulate process.

Length to tip of elytra, female, 7-7.25 mm., male, 7 mm.

Vertex one-half longer on the middle than next the eyes, subangulate; front narrowing in almost straight lines to the clypeus; clypeus broader and shorter than in *spatulatus*, base and tip slightly convex, sides parallel. Pronotum strongly emarginate behind. Elytra entirely hyaline, the veins indistinct.

Color yellowish-green. Head and thorax usually darker green, the tip of vertex, margin of venter, and dorsum of abdomen in most specimens suffused with ochreous.

Genitalia: Female, ultimate ventral segment long and with a deep notch extending to near the base and including a spatulate process as in *spatulatus*. The notch is deeper and wider and more open at the base of the spatulate process, the process is broader and reaches only half way to the tips of the sub acute lateral margins of the segment; male, valve large,

longer than in *spatulatus;* plates narrowing rapidly behind the middle, the tips upturned, divaricate and scarcely acute; a row of bristles along the outer margin, few in numbers, set in a uniform series and a few minute cilia at the extreme tips; pygofers long, exceeding plates, pointed at tip.

Described from eleven females and four males, collected at Ames, Iowa, July 4th–11th–29th, and August 3, 1896.

Except for the more yellow color and the different shape of the vertex this species resembles very closely the *spatulatus*, but there is a distinct difference in the genitalia, notwithstanding the presence of the spatulate process which is so far known only in these two species. Two males which are otherwise apparently identical with the above have the plates passing the pygofers much more acutely pointed, and the elytra distinctly infuscated at tip. It seems hardly possible that they can belong with this species, but no females agreeing with them have been seen. Dedicated to Mr. E. D. Ball.

PHLEPSIUS LOBATUS N. SP.

Color and shape of *truncatus* but slightly smaller. The female ultimate ventral segment produced at sides into a distinct obtuse lobe. Length to tip of elytra, female, 5.75 mm.; male, 5.50 mm

Head as wide as pronotum; vertex about one-third longer on middle than next eye (slightly fuller in male than in female). Front almost as wide between the eyes as length, narrowing rapidly to the apex, the margins from antennæ to apex straight. Clypeus narrowed at the base, truncate at apex; loræ large, the frontal angles sharp; genæ rounding regularly from the sinuation below the eye. Pronotum with the posterior portion distinctly concave; scutellum broad, with a sharply impressed line on the disk.

Color: Above, gray from the finely irrorate and lineated white and fuscous markings. Front dark fuscous in upper part, becoming lighter below; pectus, venter and legs whitish with fuscous maculations and points.

Genitalia: Female, ultimate ventral segment very long, depressed laterally and produced into marginal lobes, between which the posterior border is convex, the central portion elevated, becoming carinate and minutely notched at posterior border. Male, valve triangular, plates rather narrow, tapering uniformly from base to sub-acute apex.

Described from one male and one female collected at Little Rock, Iowa, July 2, 1897, by Mr. E. D. Ball, and one female at Ames, Iowa, September, 18th.

This might easily be mistaken for *truncatus*, or even for a small *irroratus*, but the genitalia are strikingly different.

INDEX.